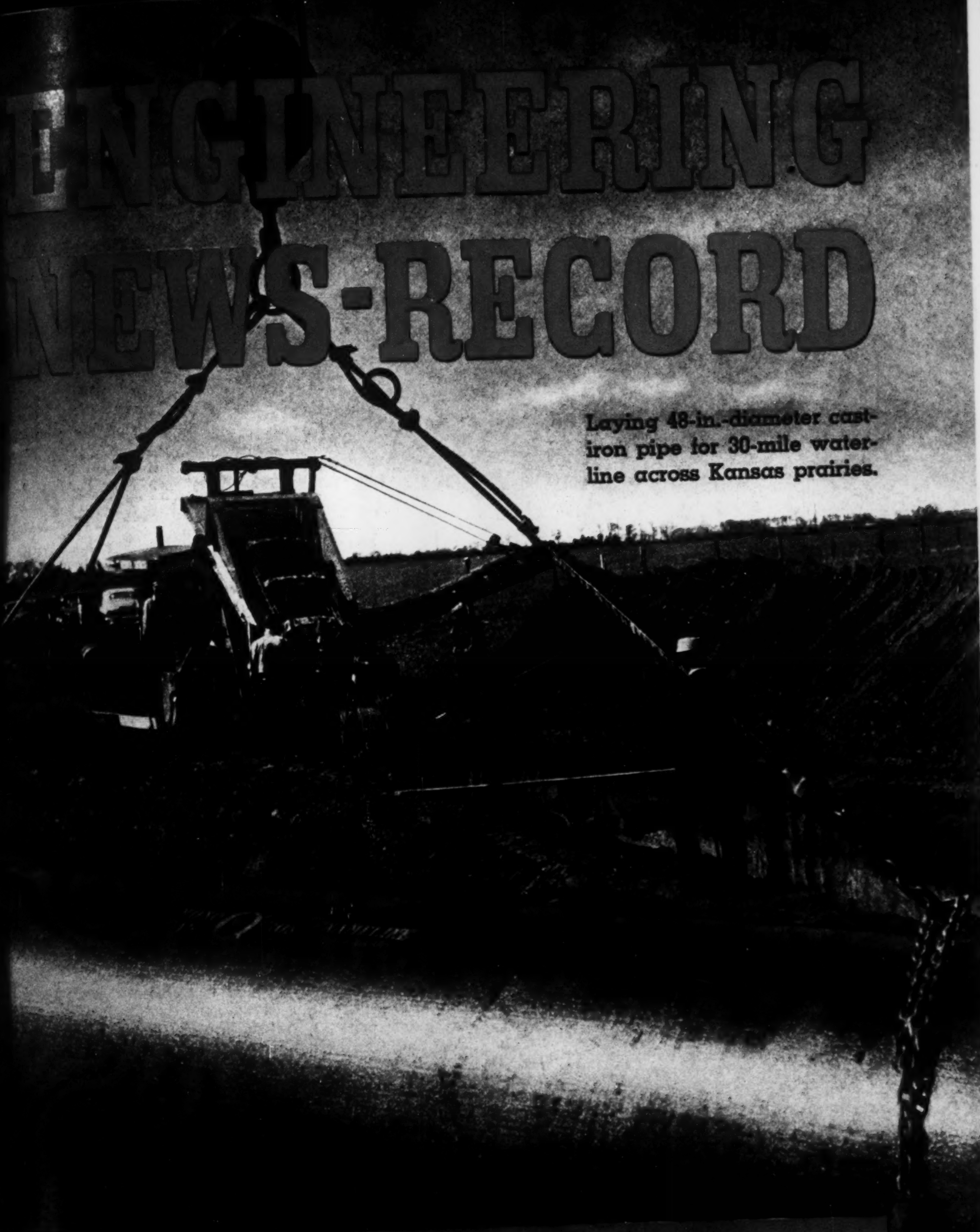
ENGINEERING NEWS-RECORD



Laying 48-in.-diameter cast-iron pipe for 30-mile water-line across Kansas prairies.

AUGUST 15
1940

New Staggered Floor Garage Design Cuts Cost

Bridging Busy Electrified Tracks at Chica

Wichita Makes Cast-Iron W

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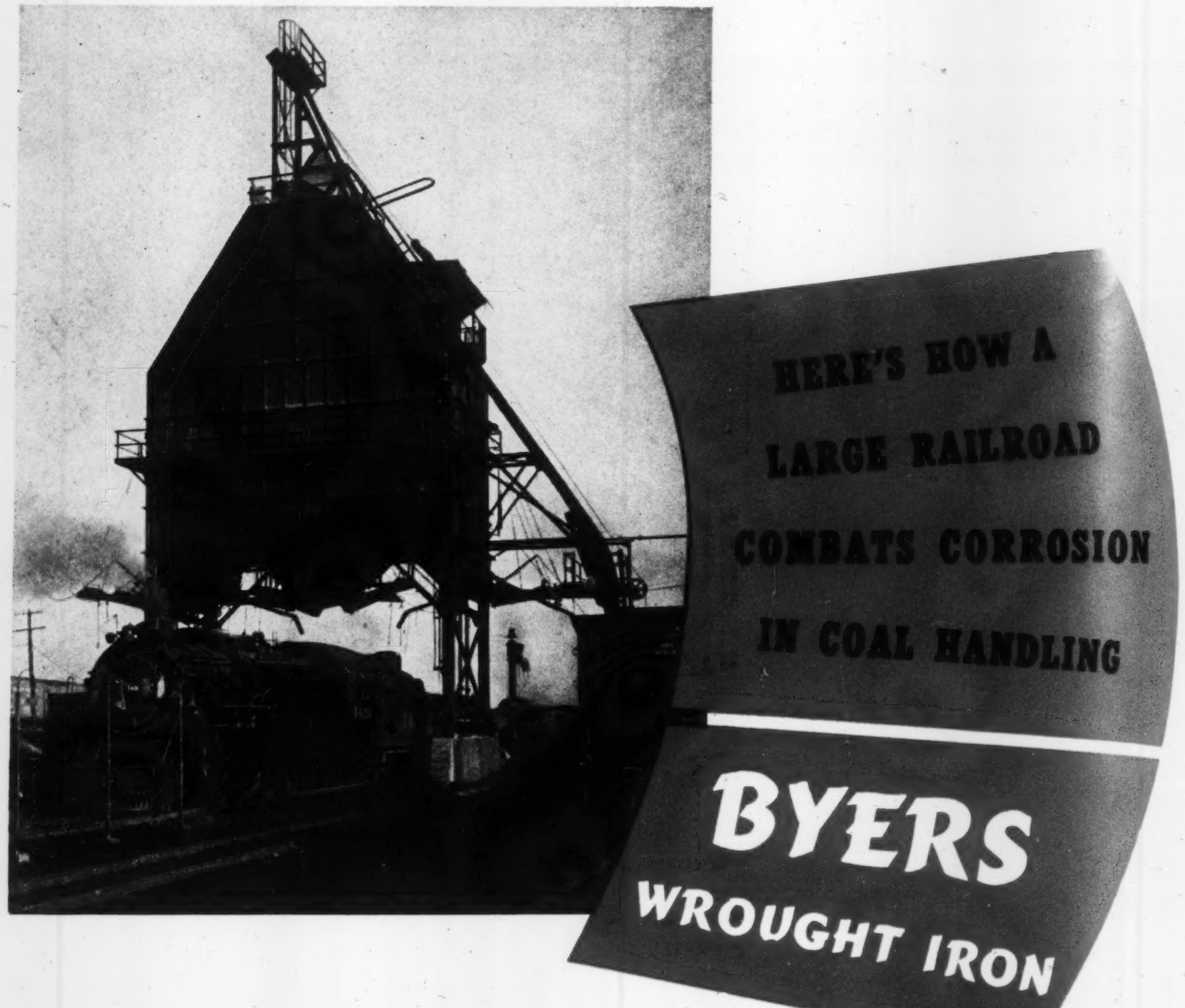
CORROSION COSTS YOU MORE THAN WROUGHT IRON



Engineers whose work has ever involved the transportation, storage or handling of coal know from experience the severe corrosion conditions resulting from sulfur in the coal uniting with moisture to form metal-destroying acids. Experience also suggests an economical and dependable answer to the difficulty . . . wrought iron. Railroads, which must live with this problem, are large users. The illustration shows the latest and biggest of 18 coaling stations utilizing wrought iron which have been built by one large railroad alone.

Wrought iron has been used for hoppers on 5-ton and 10-ton coal larries in a large Pekin (Ill.) plant. It replaced other metals which failed quickly, and has already outlasted them several times. Wrought iron coal spouts have been serving since 1934 in Oconomowoc, (Wis.), Coshocton, (O.), and Paducah, (Ky.), plants.

If your work brings a problem of this kind at any time, and you want to select materials on the basis of past experience, just write us the details. Our Engineering Service Department will provide you with data covering the performance of wrought iron under parallel conditions.

You will also find some helpful information on the corrosion problems involved, and the places where wrought iron is serving, in our bulletin, "Wrought Iron for Flue Gas Conductors and Coal Handling Equipment." We will be glad to send you a complimentary copy on request.

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BYERS GENUINE WROUGHT IRON

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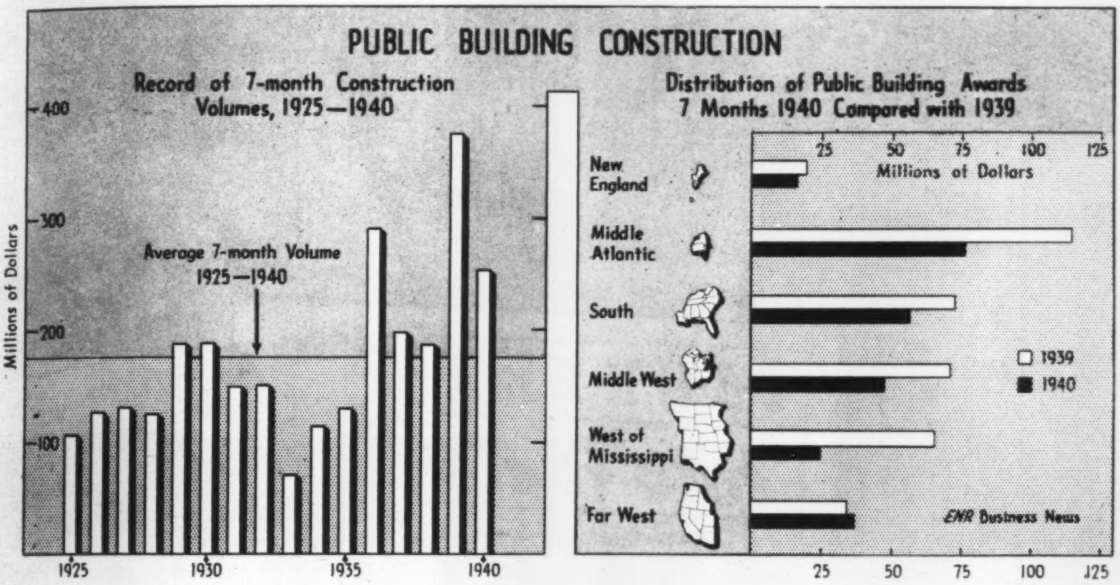
STEEL TUBULAR PRODUCTS

CONSTRUCTION TRENDS

Notes on significant movements in the construction industry



Public buildings in strong position

DEFENSE spending for increased power output, for armament plants and military housing for the government, just now getting under way, puts public buildings in a strong position to challenge the record volume of last year.

The current public building volume reached $254,200,000 for seven months, the third highest total reported since 1925. It was topped by 1939's seven-month total, and by that of 1936. A combination of PWA and USHA awards was largely responsible for last year's gain, and PWA construction paved the way for the high 1936 figure.

An important new factor to be considered in regard to public buildings is the construction of manufacturing plants with government funds under private supervision. These plants, in normal times, would be privately financed and included in industrial building statistics, but with federal departmental funds behind them and being constructed for federal purposes, they are now classified as public buildings. This type of financing will differ from the RFC loans to private industry, such as the $92,000,000 loan to the Wright Aeronautical Corporation for the expansion of its facilities, in that the structures, though built for manufacturing purposes, will be publicly owned. Contracts for the private work, though financed by RFC, will continue to be included in industrial building statistics.

ENGINEERING NEWS-RECORD. Published every Thursday, Vol. 125, No. 7. Price 25c per copy. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation, 330 West 42nd Street, New York, N. Y. Subscription, domestic, Canada, Mexico, Central and South American countries $5.00 for one year, $8.00 for two years, $10 for three years. Great Britain and British Possessions 54 shillings for one year, 108 shillings for three years. All other countries $9.00 for one year, $18.00 for three years. Entered as second class matter October 29, 1936, at the Post Office at Albany, N. Y., under the act of March 3, 1879. Printed in U.S.A. Cable address "McGrawhill New York." Member A.B.P. Member A.B.C. Copyright 1940 by McGraw-Hill Publishing Company, Inc. James H. McGraw, Founder and Honorary Chairman; James H. McGraw, Jr., President; Howard Ehrlich, Executive Vice-President; Mason Britton, Vice-Chairman; B. R. Putnam, Treasurer; D. C. McGraw, Secretary; J. E. Blackburn, Jr., Circulation Manager. Editorial and Executive Offices: 330 West 42nd St., New York. Publication Office: 99-129 N. Broadway, Albany, N. Y. Branch Offices: 520 N. Michigan Ave., Chicago; 68 Post St., San Francisco; Aldwych House, London, W. C. 2, England; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

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ENGINEERING NEWS-RECORD

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Publication Office: 99-129 North Broadway, Albany, N. Y. • Editorial and Executive Offices: 330 West 42nd Street, New York

F. E. SCHMITT AND WALDO G. BOWMAN, *Editors* • ALBERT E. PAXTON, *Manager*

Vol. 125 AUGUST 15, 1940 No. 7

THIS WEEK

- Army and Navy Fee Construction Contracts—a resumé of the provisions embodied in the cost-plus-fixed-fee contracts for national defense construction work done under the Army and Navy. Special provisions, such as the clause in the army contract which provides that wages shall be fixed by the Secretary of Labor, call for serious consideration. Details of the recently adopted subcontract agreement for Army work are given.

- New Staggered-Floor Garage Design—A design which permits speeds up to 30 mph in handling cars, effects a 60 per cent decrease in distance to storage point, eliminates forced-draft ventilation, and cuts construction cost 20 per cent was used in Los Angeles.

- Bridging Busy Electrified Tracks—Chicago park engineers used the substructure of an old bridge, and increased the roadway width from 34 to 60 ft. by means of a cantilevered deck. Pinned hangers were used at expansion joints, and a grid-type deck filled with concrete reduced the floor weight to 55 lb. per sq. ft. The work was accomplished without interference to railway traffic.

THINGS TO COME

- Millions of housing units are needed and wanted. Yet that need is not being filled, while hundreds of building trades craftsmen and technicians remain unemployed. In the *Aug. 29 issue,* Jacob Mark, engineer, tells why this is so in an analytical study of present building costs.

- Two highways in far distant states—one now being carved through the loess bluffs of Iowa, the other through the water-soaked Florida Everglades—will be featured in the *Aug. 29 issue.* Stepped slopes with vertical walls and cuts 80 ft. deep make the former the most spectacular road in the Middle West. A rockfill in a muck trench excavated to rock, wherein the use of dragline excavators and drill boats take the place of familiar grading machines, was used in the Everglades road construction.

PAGE

The Week's Events 31

Reader Comment 38

Editorials 40

Bridging Electrified Tracks L. T. SMITH and L. C. RIGGLE ... 42

Red Concrete for Slow Traffic WM. N. REES 44

A New Pipe Formula LELAND S. RHODES 45

Wichita Makes Cast-Iron Water Line History 46

New Staggered-Floor Garage Design V. LANKOVSKY 51

Refuse and Sewage Plant Combined for Profit 53

Roads That Cut Car Costs 56

Repairing a Concrete Arch Viaduct RALPH VAN BRIMMER. 58

Army and Navy Fee Construction Contracts 61

Replanning Our Cities for Living EMERSON GOBLE 63

Running Track Designed From Scratch W. E. CULLINAN, JR. 66

Direct-Current Drive for Power Shovels GEORGE H. HALL .. 67

Bridge Paint is Steam-Cleaned 70

Rock Spreader Puts Facing on Earth Dam 71

Maintenance of Large Timber Structures JOHN J. GOULD .. 72

From Field and Office 75

Unit Prices 78

Construction Reports 119

Number of copies of this issue printed: 34,885

Only one week old...

BUT TOUGH ENOUGH TO CARRY TONS!

Two Days after Atlas High-Early concrete was placed, workmen stripped the forms. And but one week after placement, the concrete carried the load of truck crane for erecting steel frame on second floor.

Saved two to three weeks' time—Atlas High-Early concrete takes load of truck crane and steel one week after placement

THREE MONTHS—that's all the time the contractor had left to finish this job. And because completion on schedule was essential, Atlas High-Early cement was specified—a cement that gains working strength in much less time than normal portland cement.

Result? The contractor reported that "they stripped forms in two days as against four to five days when using normal portland cement." And in only one week—instead of the two or three weeks required with normal portland cement—the concrete columns and floor were ready to take the heavy load of a truck crane required for erection of the steel frame for the second floor.

You also may save time, and on many jobs save money, by using Atlas High-Early cement. Give it a trial on your next job. Often earlier use of concrete, reduced cost for protection and curing, and lower form costs more than pay for the slightly higher cost of Atlas High-Early cement. Universal Atlas Cement Co. (United States Steel Corp. Subsidiary), Chrysler Bldg., N.Y.C.

NR-H-18

ATLAS HIGH-EARLY CEMENT

A UNIVERSAL ATLAS PRODUCT

The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • AUGUST 15, 1940

Army lays ground work for fast start on construction

Construction quartermaster has assembled names and and qualifications of nearly two thousand contractors and engineers who are available for fee contracts

R. Colborn
Washington Office
Engineering News-Record

Although the War Department is proceeding slowly (as contrasted with the Navy) in actual award of defense construction contracts, good progress is being made in formulation of machinery to select contractors and engineers to do the work. The names and qualifications of about 1,900 firms are now in the files of the Quartermaster General.

Actual work of selection of both contractors and engineers is in the hands of the quartermaster's "Construction Advisory Section" (*ENR* Aug. 1, 1940, p. 134). This is a five-man board of civilian experts appointed some weeks ago. Members whose names have been made public are Forest Harvey, chairman, Francis Blossom, and F. J. C. Dresser.

When a contractor writes or travels to Washington to find out how to be considered for negotiated contracts he receives a mimeographed sheet telling him to write a letter to the Quartermaster General setting forth the following information: His experience both on fee and competitive bid construction, what organization he has available, including architectural and engineering services, equipment and financial resources. In connection with the experience items, he is asked to include type, location, and cost of work.

Engineers' records

Engineers are asked to present a full experience record with names of clients and location, type, and money value of projects. They should also describe their organization, "with particular view to rapid completion of plans and specifications," as well as including a list of projects designed for federal agencies.

No one is summoned to Washington for an interview, but the board is interviewing all contractors who apply. Hired lobbyists and exerters of political pressure are not being well received. What happens at the interview is that the board gets out the contractors letter of application and goes over it with him, making sure that his qualifications are fully and accurately set forth. From that point on there is not much a contractor or engineer can do except sit back and wait. If he gets a job he will be told so.

From the information collected by mail or by interview a file is set up. Contractors are classified by type of work they do and by the size of job they are equipped to handle. This last is determined, not according to any accounting formula, but on the basis of work done in the past, the contractor's own estimate, and the board's judgment based on his equipment and staff.

Regional limitations

Contractors are also classified in the files by states, but this is purely for convenience and should not be taken to mean that a firm is only eligible for work in its own state. On jobs running to more than about $5,000,000 geographical elements do not enter into the selection. On smaller jobs, the intention is to assign the work to nearby contractors, but the meaning of "nearby" will vary with each job; the smaller the job, of course, the smaller the area from which contractors will be drawn.

Procedure, when a project is ready to let, is for the board to draw from their files names of twenty or thirty firms that appear eligible on the basis of type, size, and location. Using the application and their own knowledge of the industry, the board winnows this list down to three contractors and, perhaps, three engineers. These names are then submitted to General C. D. Hartman, head of the construction division of the Quartermaster Corps, who makes his selection from the three and calls the chosen firm in to negotiate a contract.

Army Signal Corps Photo

Heads army supply division

Col. Eugene Reybold, division engineer at Little Rock, Ark., has been named assistant chief of staff of the Army to head the supply division—G-4—of the General Staff to fill the post made vacant by the recent promotion of Brig. Gen. R. C. Moore. In his new post Col. Reybold will be responsible for planning and policy setting in connection with military purchasing and construction.

Col. Reybold, who is 54, graduated in civil engineering from Delaware College in 1903. He joined the army five years later as a coast artillery officer, and in 1926 transferred to the Corps of Engineers to act as district engineer at Buffalo. He served there from 1927 to 1932. After a year in Washington on the Board of Engineers for Rivers and Harbors, Reybold became district engineer at Wilmington, N. C., and then at Memphis. He went to Little Rock in 1937.

• • •

Texas firm plans $80,000,000 pipeline

The Reserve Gas Pipe Line Co., Dallas, Texas, has applied to the Federal Power Commission, Washington, D. C., for a permit to construct and operate a 1500-mile pipeline starting in Texas and ending in the state of New York. Estimated to cost about $80,000,000, the pipeline would serve customers in the Philadelphia, New Jersey and New York City areas.

Record rains flood south central Louisiana

Maximum of 31.66 in. in four days makes evacuation of between 10,000 and 15,000 necessary

With an initial high storm tide filling coastal marshes and slowing runoff, record-breaking rains in south central Louisiana during the 96-hr. period ending Aug. 10 resulted in the flooding of an area about 70 miles long and up to 50 miles wide making it necessary to evacuate from 10,000 to 15,000 persons. Marooning of thousands of others in dwellings also resulted.

The heavy rainfall extended nearly 100 miles in from the Gulf coast covering most of the area between the Texas-Louisiana border and the Mississippi River as far north as the Red River.

A tropical disturbance that entered the mainland near Port Arthur, Tex., Aug. 7, to travel eastward caused the torrential downpour. At Abbeville, La., a total rainfall of 31.66 in. in four days, including 17.50 in. in 24 hours, comes close to the record for any one month for the state of Louisiana, which is 36.91 in. received at Alexandria in June, 1886.

At Lafayette the 96-hr. total was 26.95 in., including 19.63 in. for the 24-hr. period ending Aug. 9. This is a new record for a 24-hr. rain for southern Louisiana, the old record being 18.50 in. recorded at Pharr on April 15, 1927. (The all-state record for a 24-hr. rain is 21.4 in., which was received at Alexandria June 16, 1886.)

During four days the precipitation totaled 9.04 in. at Morgan City, 14.36 in. at Melville, and 11.72 in. at Lake Charles. At Alexandria six days of continuous rain ending the morning of Aug. 6 amounted to 4.73 in. After a one-day letup, 2.99 in. additional fell in two days.

During the peak flood 80 per cent of the land extending 50 miles inland from the coast line between New Iberia and Lake Charles, a distance of 70 miles, is said to have suffered from overflow. At Crowley water stood 2 ft. deep in stores, and at Gueydan, where streets were flooded by six feet of water, the town's population had to seek shelter in rice warehouses or schools. From Crowley to Lafayette a railroad embankment presented the only dry land. The Calcasieu River rose 7.8 ft. above normal high water at Lake Charles with a maximum height of 8.2 ft. forecast.

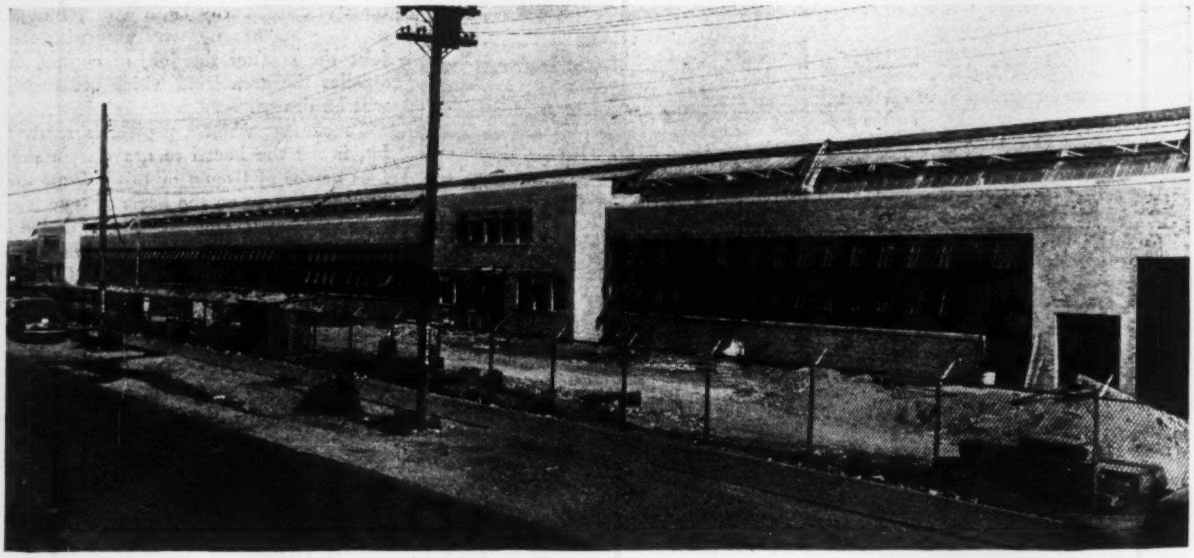
Damage to highways is as yet unknown but it is not expected to be high because of the flat terrain which prevails in this part of the country.

Baltimore names advisers to plan commission

Long-range planning of all facilities of Baltimore will be undertaken by a newly created three-member board of advisory engineers which will report to the city plan commission. This is the first time a city has initiated concentrated planning of all facilities.

According to Abel Wolman, chairman of this special board, the advisory engineers are assigned the task of developing the plans for the physical facilities of Baltimore for the next 20 to 25 years. It has the job of inquiring into the present status and developing the future programs for all of the physical facilities of the city, such as water supply, sewerage, refuse disposal, highways, schools, parks, and recreation areas. In other words, the commission on city plan has delegated to this board comprehensive tasks of laying out the facilities for the city for several decades to come. These plans are then to serve as the basis for long-term city planning and capital budgeting.

Other members of the board beside Wolman are G. J. Requardt, consultant for the Public Improvement Commission at Baltimore, and Nathan L. Smith, former chief engineer of the Maryland State Roads Commission.



This aircraft factory built in 40 days

Although the contract for this one-story mezzanine monitor type 640 x 280-ft. factory building was not awarded until June 5, the plant was completed August 10 or 40 working days after construction had begun. It was built for Pratt & Whitney Aircraft Division of the United Aircraft Corporation, East Hartford, Conn. The owners began moving in to the new plant on Aug. 3, or 33 days after the contractor started work.

Designed by Albert Kahn, Inc., architects of Detroit, construction comprises a total of 187,000 sq.ft. of floor space. The framework is featured by the use of bowed steel trusses for the 64 x 64-ft. column spacing. Material required included 1,100 tons of structural steel, 7,600 tons of concrete, a quarter of a million brick for the exterior wall construction, an acre and a quarter of sash and glass, 20,000 linear feet of copper flashings, and 4 acres of roofing and cork insulation. Labor represented a total of 7,100 man-days.

Turner Construction Co., New York, was the contractor for the work.

Housing program in chaotic condition

Opponents of appropriation direct to Navy propose President spend $300,000,000 as he sees fit

The defense housing problem, on the legislative side, is still in a chaotic condition. An original proposal embodied in a naval public works bill to authorize USHA to borrow $250,000,000 for housing of workers in defense plants and for enlisted men was repudiated last week by Chairman Vinson of the House naval affairs committee, who announced he would strike it out and substitute a $70,000,000 appropriation direct to the Navy. This week Senator Wagner, apparently with administration support, proposed a $300,000,000 appropriation direct to the President, to be allocated to whatever agency he saw fit. This would get around the unpopularity in the House of USHA and would presumably give the power of the purse to C. F. Palmer, defense commission housing coordinator.

Palmer, meanwhile, is going ahead setting up procedures without knowing where the money is coming from. He takes very seriously his declaration that private capital will get first crack at defense housing. In communities where his agents find that housing is needed, realtors and builders will be acquainted with the situation and urged to go ahead. Administration and Navy officials, however, who characterize housing as a potential bottleneck in defense production, pointing to alarmingly high labor turnover at some plants, doubt that private capital will want to enter a market that may fold up at any time.

• • •

Record span advised for Mackinac Straits

Reporting to the Mackinac Straits Bridge Authority of Michigan, Lansing, Mich., Modjeski and Masters, consulting engineers, Harrisburg, have recommended for the Straits of Mackinac a $26,740,000 bridge with two suspended spans, one of which would have a central span of 4,600 ft., the longest in the world. The bridge, which would join Mackinac City and St. Ignace, Mich., would have a total length of 17,000 ft. and would include two suspension bridges with a common center anchorage, one 5,180 ft. in length and the other 7,942 ft. from anchorage to anchorage.

Deep water and heavy ice movements make the site a difficult one to bridge.

Of the total cost $21,950,000, is estimated as needed for actual construction and $1,425,000 for administration and engineering costs, $965,000 for causeways and $2,400,000 for financing. The possibility of including railroad facilities on the proposed bridge was discouraged because it would involve about $16,000,000 additional cost.

A 33-ft. roadway would provide three lanes of traffic, two lanes to be for traffic in the direction of the peak load and the other lane for traffic in the opposite direction.

• • •

Bayonne, N. J. terminal desired for Navy

President Roosevelt has asked Congressional approval to purchase the city-owned 160-acre ship-to-rail terminal at Bayonne, N. J., for use as a navy supply depot and possible repair base.

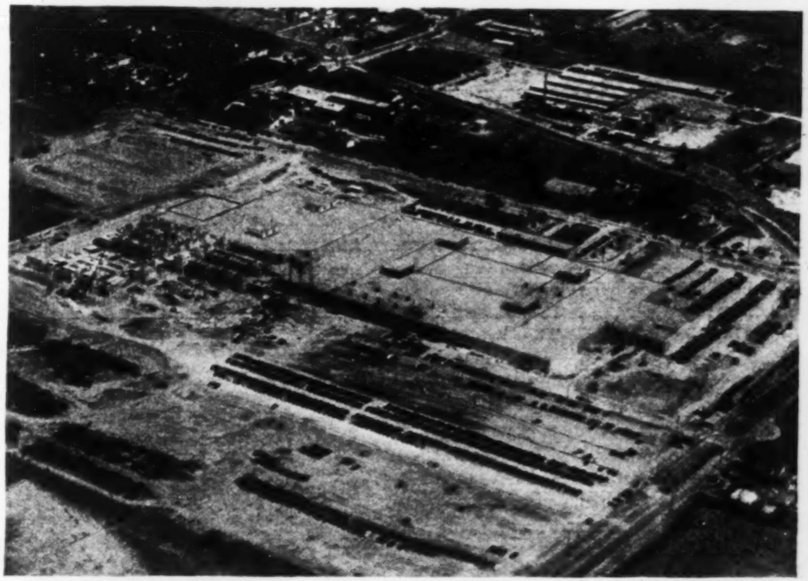
According to Mayor James J. Donovan of Bayonne, the Navy Department also favors Bayonne as the site for the 1,000-ft. super drydock proposed by the Port of New York Authority for accommodation of the 45,000-ton battleships now under construction for the Navy. This latter work is estimated to cost between $14,000,000 and $17,000,000.

Plans complete for Purdue soil mechanics conference

Arrangements for the conference on soil mechanics to be held at Purdue University, Sept. 2-6, are now complete, according to P. C. Rutledge, associate professor of civil engineering at Purdue, who is in charge of arrangements.

Topics to be covered during the conference include: "The Scope of Soil Mechanics and Soil Mechanics Instruction," "Instruction in the Applications of Soil Mechanics," "Practical Engineering Appraisals of Soil Mechanics," "Sampling, Identification, and Classification of Soils," "The Physical Properties of Soils and Their Determinations," "The Mechanics of Rupture in Soils," "The Mechanics of Deformation in Soils," and "Soil Mechanics Applied to Highway Engineering."

Those planning to attend the conference and wishing to make reservations, including purchase of the printed proceedings of the conference, should write Rutledge.



Fairchild Aerial Surveys Photo

To be an important plant in defense work

Vital to the national defense is this ultra modern plant at Indianapolis, Ind. where General Motors turns out its Allison airplane engine. Reason for its importance is that the Allison is the only V-type liquid-cooled engine of high power manufactured in this country. For many years U. S. military planes have used radial air-cooled engines, and a large capacity for their production — approaching 2,000 a month — has been built up. Recently it has been found that the streamlined character of the liquid-cooled engine offers advantages in high-speed pursuit airplanes, and at present nearly all the fast fighters being built for the Army are designed for the Allison engine — a 1,000-hp. V-12. At the middle of next year, Packard will start building the similar Rolls-Royce Merlin, but until then all the engines for such airplanes as the Curtiss P-40, the Lockheed P-38, and the Bell Aircobra and Aircuda have to come from this plant or the old smaller Allison plant.

The plant is of single-story windowless design and is air conditioned. It is understood to have a capacity of about 500 engines a month, though production difficulties have so far held output, now about 130 a month, to much lower levels.

Cost and other details of the work are not available at this time.

WASHINGTON HIGHLIGHTS

An Army engineer, Col. Donald H. Connolly, has been appointed Administrator of Civil Aeronautics—a job created by the President's recent reorganization of the Civil Aeronautics Authority, placing it in the Department of Commerce. Under the general direction of Assistant Secretary of Commerce Robert Hinckley, former chairman of CAA, Col. Connolly will handle the pilot training program, enforce safety regulations, and administer the federal airways. Col. Connolly has been on troop duty for the past year, in command of the 2nd Engineers at Fort Logan, Col., but for four years previously he was WPA director at Los Angeles. The Colonel, who is 54, worked on construction of the Panama Canal and has been District Engineer at Memphis and at Chicago. A major part of his career has been on troop and staff duty.

Plans to replace or rehabilitate 2,000 weak highway bridges announced last week in the defense commission's radio "progress report" do not indicate any brand new program. The work is to be done under federal-aid procedure. What has happened is that the Public Roads Administration has made a study of the War Department's 80,000-mile system of priority highways using the state highway inventories underway for the past several years and now approaching completion. This revealed about 2,000 bridges on strategically important roads which fail to meet the H-15 standard desired by the military. The lists have been submitted to the state highway departments with the request that they estimate the cost of putting the bridges in shape over the next two years.

The pending highway bill, now in conference, would authorize PRA to enforce military priorities in approving state highway programs.

It is not believed that the cost of the bridge work would exceed in any state the road funds available over the next two years. In view, however, of the uneven distribution of the bridge work among the states—with the East in the worst shape—and of the desirability of continuing normal road work, Congress may decide to provide additional money. However, no such legislation is now being prepared.

The Wheeler-Lea transportation bill, which would bring water carriers under the jurisdiction of the Interstate Commerce Commission, got a new lease on life this week when a conference committee reported and the House passed a new version of the bill, which had been believed dead when the two houses disagreed on it this Spring. The new version eliminates a clause forbidding rates so low as not to be compensatory; this had been sought by water carriers to protect them against railway rate-cutting. Provisions to protect labor in railway consolidations are loosened somewhat.

• • •

Winston-Salem code changed to aid builders

Aimed to provide a saving on protection bonds for contractors, who are forced to block portions of streets or sidewalks, a new amendment to the city building code of Winston-Salem, N. C., provides that for a small fee contractors can obtain a permit for their work which automatically provides coverage under a blanket policy carried by the city. The size of the fee depends on the size of the job, a permit for a job of $2,000 or less costing $1 with the fee increasing five cents on every $100 for work above $2,000.

Under the old ordinance, the contractor was required to purchase protection bonds at a minimum cost of $25.

This amendment is in keeping with recent revisions of the Winston-Salem building code, starting in 1939 (*ENR*, Oct. 5, 1939, p. 438).

JOBS OF THE WEEK

AIRPLANE FACTORY, Burbank, Calif.

William Simpson Construction Co., Los Angeles, was awarded the contract for constructing seven reinforced concrete buildings with 579,000 sq. ft. floor space for Vega Airplane Co., Burbank. Cost of buildings is estimated at $2,000,000, with equipment estimated to cost another $1,500,000. The plant will have a 218,000-sq.ft. paved ramp for outside assembly work.

STEAM PLANT, Norfolk, Va.

Stone & Webster Engineering Corp., was awarded the contract by Virginia Electric & Power Co., Richmond, Va. for constructing a 40,000-kw. steam plant at Norfolk, Va. Estimated cost of the work is $4,000,000. The plant is to increase, for defense purposes, the power output in the Hampton Roads district.

POWER EQUIPMENT for Boulder Dam Power House

Allis-Chalmers Mfg. Co., Milwaukee, Wis., will construct the 115,000-hp. turbine and pressure regulators for the Arizona wing of the Boulder Dam power house for the Bureau of Reclamation, Denver, Colo. Power from the new unit will be used by Southern California Edison Co., which serves consumers in seven counties in Southern California. Cost of the work is $584,000.

RUNWAYS, Seattle, Wash.

Warren-Northwest, Inc., Portland, Ore., was awarded a $546,267 for surfacing the landing field runways at the Sand Point Naval Air Station, Puget Sound, Wash. Public Works Officer, Puget Sound Navy Yard, awarded the contract.

EXCAVATING, HUDSON RIVER, at Troy, N. Y.

Dunbar & Sullivan, Detroit, Mich., were lowest bidders with a bid of $576,434 for removal of 175,360 cu.yd. of ledge rock and 231,000 cu.yd. of other material from the Hudson River between the Troy-Menands Bridge and the Troy Barge Canal Terminal. U.S. Engineers, New York District, New York, took bids for the work Aug. 9.

DISPENSARY, SHOP and SHIP WAYS, Phila., Pa.

Hughes-Foulkrod Co., Philadelphia, Pa. was awarded a $855,000 contract on a cost-plus-fixed-fee basis for constructing a dispensary, electric shop extensions, ship fitters shop, shipways No. 2 and 3, and crane runways at Philadelphia Navy Yard. Bureau of Yards & Docks, Navy Department, Wash., D. C. awarded the contract.

LOW COST HOUSING PROJECT, Detroit, Mich.

Maurice L. Bein, Inc., Chicago, Ill., was low bidder with a bid of $8,300,000 for constructing according to the steel design the S. James Herman Gardens Housing Project; A. Smith & Co. and Lipman Construction Co., Chicago, Ill., were low bidders on the masonry design with a bid of $8,330,000. The Detroit Housing Authority, Detroit, Mich., opened the bids Aug. 6. George D. Mason Associates, Detroit, are engineers and architects for the work.

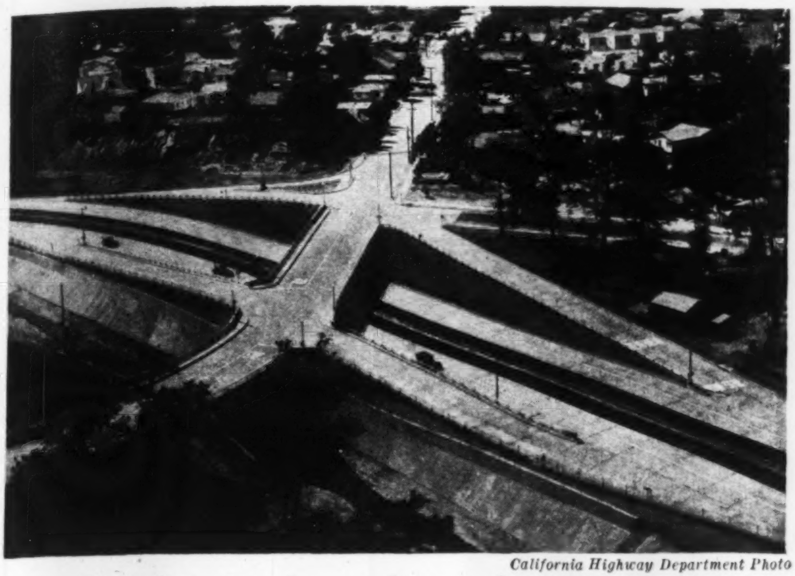
HANGARS, MacDill Field, Fla.

Central Construction Co., Atlanta, Ga., will construct the air base hangar and flight hangars Nos. 2 and 3 for the Constructing Quartermaster, MacDill Field, Fla. under provisions of a $1,065,000 contract.

BUILDINGS at NAVAL ACADEMY, Annapolis, Md.

McCloskey & Co., Phila., Pa., will construct additional buildings and accessories at the Naval Academy for the Bureau of Yards and Docks, Washington, D. C. on cost-plus-fixed-fee basis. The work will cost $1,210,000.

NOTE—Additional bidding and contract news on over 600 projects, large and small, appear in the Construction News Section beginning on page 119.



California Highway Department Photo

First Los Angeles parkway placed in service

On July 20 a 3.7-mile section of the Arroyo Seco Parkway at Los Angeles, first limited access parkway for that city, was opened to traffic. The portion now in use extends from Ave. 40 in Los Angeles to Glenarm Ave. in Pasadena. Completion of the entire 6-mile project is anticipated by Nov. 1 at a total cost of more than $5,000,000. Then a parkway free of grade crossings will be provided between Los Angeles and Pasadena.

The above view shows separation of the two 35-ft. concrete roadways by a center strip, also the ramps at Ave. 52 for entering and leaving the parkway. Also shown running parallel to the parkway is the newly constructed concrete channel for the Arroyo Seco floodwaters, which was built by the city of Los Angeles and U. S. Engineers.

The work was carried out by the California State Highway Department by contract with the cities benefited by the parkway contributing financial aid.

Additional details of the work are given in ENR, July 21, 1938, p. 79.

Ohio has record highway program

A total of $14,496,000 of new construction on the state highway system undertaken for the first seven months of the year, the Ohio State Highway Department has under way the greatest road building program in the history of the state. A total of between $19,000,000 and $20,000,000 is expected to be expended during the entire year of 1940.

• • •

Work on Pacific airbases far ahead of schedule

Three of the four airbases the Navy started building last year on small Pacific Islands (*ENR*, Aug. 17, 1939, p. 195) are being pushed forward so fast that they are months ahead of schedule and the fourth is up to schedule. The $5,714,000 base at Kaneohe Bay, Oahu, scheduled for completion in October, 1941, will be finished ten months earlier, or in December of this year. At Palmyra Island, the $1,510,000 base is eleven months ahead, with completion now set for July 1941 instead of May 1942. The Johnston Island base, a $1,030,000 job, will be completed in August 1941, seven months ahead of the original March date. The $3,720,000 Midway Island base is running on schedule. The four bases are being built as part of contract held jointly by Hawaiian Dredging Co., Honolulu; Raymond Concrete Pile Co. and Turner Construction Co., both of New York, which included $2,633,000 of work at Pearl Harbor, Hawaii. In July of this year these three firms joined with Morrison-Knudsen Co., Los Angeles, and J. H. Pomeroy & Co., San Francisco, in a contract for $30,870,000 additional work at the Pacific bases.

• • •

Bear Mountain Bridge bought by New York

The Bear Mountain Bridge, a suspension span across the Hudson River 3½ miles north of Peekskill, N. Y., has been bought by the New York State Bridge Authority from the Bear Mountain Hudson River Bridge Co. for $2,275,000. State operations will begin September 25, when a flat toll of 50 cents per vehicle will go into effect. Tolls are now 80 cents a car and driver, plus 10 cents for each additional passenger.

Originally the Bear Mountain Bridge, completed in 1925, cost $5,500,000.

TVA adopts labor-managementagreement

Construction labor groups join in move to adjust disputes and end strikes

A labor-management agreement has been signed by the Tennessee Valley Authority and the Tennessee Valley Trades and Labor Council which sets up new arrangements for settling disputes over pay and working conditions and which outlaws strikes during negotiations to settle disagreements between labor and management. The labor council is made up of 15 unions representing the painters, boilermakers, blacksmiths, machinists, electrical workers, building and common laborers, operating engineers, sheet metal workers, lathers, cement finishers, plumbers and steam-fitters, carpenters, bricklayers, masons and plasterers, teamsters and asbestos workers. These include most of the workers on TVA dam construction, transmission line building, plant operation and maintenance.

The agreement is an extension of the labor policy adopted by the TVA in 1935 (*ENR*, Oct. 10, 1935, p. 511), which policy is made a part of the new agreement. The 1935 policy statement related chiefly to collective bargaining, pay and working conditions; it had no provision for settlement of strikes. The new agreement attempts to eliminate strikes by the following provision:

> The public interest in an undertaking such as the TVA always being paramount, the authority and the Tennessee Valley Trades and Labor Council on behalf of the employees further agree that pending the determination or adjustment of any issue arising between them by means of the conference machinery and procedures hereby set up and during the life of this agreement, the authority will not change the conditions incorporated in written schedules or recorded understandings between the authority and the council out of which the issue arose, and the council or its member organizations will not encourage or sanction employees leaving the service.

The new agreement does not set up a closed shop. By incorporating the 1935 labor policy statement it guarantees employees against discrimination due to membership or non-membership in any organization.

Wage rates are to be the subject of annual conferences for the purpose of a joint determination that they are prevailing rates for the Tennessee Valley as called for in the TVA act. Joint conferences also will regulate and determine labor conditions. Maintenance of an adequate apprentice system is called for.

The rights of the TVA management to adjust its construction and operating schedules to meet national demands, including the demands of national defense, is recognized. The unions accept responsibility for setting jurisdictional boundaries to eliminate jurisdictional disputes.

OBITUARY

Stanley P. Rockwell, 54, metallurgist and inventor of the hardness tester bearing his name, lost his life in a yacht explosion on the Connecticut River at Middletown Aug. 11. He was the recipient of the Sauveur award for achievement in metallurgy in 1939.

O. G. F. Markhus, 67, assistant engineer, U. S. Bureau of Reclamation at Grand Coulee Dam, died in Mason City, Aug. 1. Markhus, an engineering graduate of the University of Minnesota, prior to his work with the Bureau served in engineering and executive capacities with the Idaho Power Company, the General Cable Corp. of New York and the Federal Land Bank at Spokane.

Lawrence A. Downs, 68, chairman of the board of the Illinois Central R. R., died Aug. 10, in Chicago. Downs, chairman of the board since September 1938, was president of the board from 1926 to 1938. He graduated in civil engineering from Purdue University in 1894, and in 1896 joined the Illinois Central as rodman to be appointed roadmaster two years later.

John C. Storey, 60, manager of the purchasing and stores department, Shell Oil Co., San Francisco, died July 26. A civil engineering graduate of the University of Washington, he helped organize, following post-graduate study in Stanford University, a firm in Seattle which did engineering work for the Shell Oil Co.

William E. Emmett, 53, San Francisco district engineer for the American Institute of Steel Construction, Inc., died in Oakland, Calif., July 16.

Daniel F. Nellis, 84, retired building contractor who with his two sons Paul F. and Harry H. Nellis founded the D. F. Nellis Co., died in Fast Liverpool, Ohio, August 5.

George M. Luther, Muskogee, Okla., southern district engineer of the Missouri-Kansas-Topeka R. R., died at Parsons, Kans., Aug. 2.

Oliver Wendell Jones, 34, civil engineer employed by the Los Angeles department of water and power, died Aug. 4.

John A. Starr, 71, formerly connected with the John E. Palmer Corp. and Coleman Bros., Boston contractors, and designer of the parks at Plymouth Rock and the Provincetown Pilgrim Monument, died at Pembroke, Mass., Aug. 4.

San Francisco bay bridge tops traffic records

Traffic on the San Francisco-Oakland Bay Bridge has steadily increased as tolls have been reduced until this year records for the month of June showed this bridge to have risen to first place, in the amount of automobile traffic carried, on the list of toll bridges and tubes of the United States. Comparative figures for this bridge and other major structures, from which free vehicles have been eliminated to make the totals truly comparable, are listed below.

The corresponding July traffic record for the San Francisco Bay bridge, just received, is 1,513,120 vehicles.

	May 1940	June 1940
San Francisco-Oakland Bay Bridge	1,182,042	1,345,786
Delaware River Bridge	1,199,852	1,318,662
Henry Hudson Bridge	1,167,033	1,263,634
Holland Tunnel	1,111,826	1,195,437
Triborough Bridge	1,004,468	1,101,731
George Washington Bridge	703,851	845,721

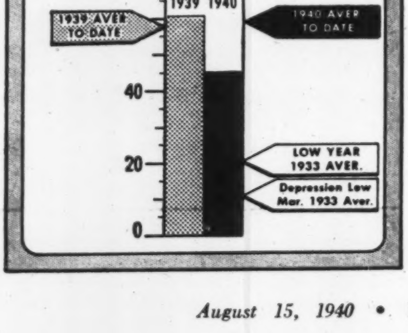
CONTRACTS AND CAPITAL

Engineering construction awards for the week total $45,305,000, a decrease of 41 per cent from a week ago, and 26 per cent lower than the volume reported for the corresponding week a year ago.

Private awards for the week top last week by 49 per cent, but they are 22 per cent lower than last year. Public construction is 57 and 27 per cent lower, respectively, than a week ago and a year ago.

The current week's construction brings 1940 volume to $1,948,828,000, 1 per cent above the $1,927,456,000 reported for the 33-week period in 1939. Private awards for the period are 21 per cent higher than last year, but public is 6 per cent lower in spite of a 130 per cent increase in federal work.

In the classified construction groups, gains over last week are registered in sewerage, industrial and commercial buildings, streets and roads, and unclassified construction. Comparisons with the 1939 week show gains in commercial buildings, and in highway construction.



New capital for construction purposes for the week totals $34,174,000. This compares with $311,744,000 for the 1939 week when the $296,000,000 appropriation for WPA construction was added. The current week's financing is made up of $33,880,000 in state and municipal bonds, $210,000 in RFC loans for public improvements, and $84,000 in corporate security issues.

New construction financing for the year to date, $1,923,067,000, is 9 per cent below the $2,122,480,000 reported for the 33-week period in 1939.

CONTRACTS

(Thousands of dollars)

	Week Ending		
	Aug. 17 1939	Aug. 8 1940	Aug. 15 1940
Federal	$6,719	$40,558	$7,997
State & Municipal	31,782	24,213	19,944
Total public	$38,501	$64,771	$27,941
Total private	22,350	11,682	17,364
TOTALS	$60,851	$76,453	$45,305

Cumulative
1940 ....(33 weeks)...$1,948,828
1939 ....(33 weeks)...$1,927,456

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative	
	1939 33 Wks.	1940 33 Wks.
NON-FEDERAL	$994,452	$1,114,495
Corp. Securities	152,799	124,585
State & Mun.	397,501	585,023
R.E.A. loans	89,445	....
U.S.H.A. loans	160,852	104,728
R.F.C. loans	3,855	116,159
Fed. Air-Hwy	190,000	184,000
FEDERAL	$1,128,028	$808,572
TOTAL CAPITAL	$2,122,480	$1,923,067

FHA MORTGAGES

	Week Ending		
	Aug. 12 1939	Aug. 3 1940	Aug. 10 1940
Selected for appraisal	$20,977	$25,110	$27,054*

Cumulative
1940 ....(32 weeks)....$791,515*
1939 ....(32 weeks)....$729,992

* Subject to revision.

ENR INDEX NUMBERS

Index Base = 100	1913	1926
Construction Cost	Aug. '40..242.18	116.42
Building Cost	Aug. '40..201.71	109.04
Volume	July, '40..308	135

U. S. Bureau of Reclamation

First cars drive along top of Grand Coulee Dam

Sufficiently complete is a 700-ft. length of the crest of Grand Coulee Dam to permit cars to use this portion of the 30-ft. roadway. However, not until 1942, when the dam is scheduled for completion, will it be possible to drive the entire 4,300 ft. from abutment to abutment.

Maximum height of the dam above bed rock of the Columbia River is 550 ft.

Shasta concreting equipment from 15 cities

Indication of the wide spread of expenditures involved in heavy engineering construction is given by the accompanying partial list of cities in which manufacturers had equipment for just one of the contracts on the Central Valley Project in California, namely, Shasta Dam, under contract to Pacific Constructors, Inc.

The equipment listed below relates only to concrete mixing and placing. If the materials that go into the dam and the manifested machinery and appliances required for other operations were included, the list would be swelled many times.

Gary, Ind.	American Bridge Co.	steel for cableway towers
Trenton, N. J.	American Steel & Wire Co.	locked coil cables
Milwaukee, Wis.	The Koehring Co.	concrete mixers
Champaign, Ill.	The C. S. Johnson Co.	concrete batching equipment
Seattle, Wash.	Colby Steel & Engineering Co.	head tower elevator
Antioch, Calif.	Goodrich Rubber Co.	conveyor belt
Willard, Ohio	Pioneer Rubber Co.	conveyor belt
Elizabeth, N. J.	Lidgerwood Co.	cableway equipment
Schenectady, N. Y.	General Electric Co.	motors and control equipment
Minneapolis, Minn.	American Bridge Co.	structure for concrete plant
Los Angeles, Calif.	Consolidated Steel Co.	tail tower steel
New Britain, Conn.	Fafner Bearing Co.	cable anchor roller bearings
Mishawaka, Ind.	Dodge Mfg. Co.	conveyor drive machinery
Los Angeles, Calif.	Conveyor Co.	conveyor troughing idlers
Pittsburgh, Pa.	Westinghouse Elec. & Mfg.	gear motors
Catasaugua, Pa.	Fuller Co.	cement unloaders & transport pump

Road builders must pay tax in South Dakota

The South Dakota State Highway Commission has notified all contractors that the state retail sales tax and use tax law affects all materials purchased by contractors for use in constructing highways, bridges and other structures for the commission. It has also been pointed out that clearance certificates shall be attached to the contractor's contract stating that all sales and use taxes have been paid on materials and equipment used in connection with the construction and operation of the contract for a particular project.

BRIEF NEWS

Contractors awarded state construction jobs in Nebraska not only must supply insurance to cover injuries to workmen but also insurance for property damages, according to a recent ruling of the assistant attorney general of the state. The opinion was handed down in answer to a query from State Engineer A. C. Tilley, who asked for an interpretation of the word "injuries" in a Nebraska law.

The new toll highway bridge across the Ohio River at Owensboro, Ky., was dedicated July 30. Providing a two-lane roadway, the bridge was built by the Owensboro Bridge Commission with a PWA grant at a cost of $1,730,000.

City officials of Harrisburg, Pa. have banned admittance to the city's filter plant and pumping station because of fear of sabotage. At the Harrisburg city hall it was also announced that no more city maps would be sold unless the purchaser was a resident of the city and had "sound reason" for wanting the maps.

The Tennessee Valley Authority plans a three-day celebration Aug. 31-Sept. 2 for dedication of the ten TVA lakes as recreational facilities for the area. Activities will be centered at Chickamauga Lake, and Aug. 31 has been set aside as "Engineer's Day." That day's program, as tentatively planned, will begin with an informal breakfast followed by an inspection tour of the Chickamauga Dam, a luncheon, presentation of moving pictures showing the many phases of construction and the application of new engineering practices as applied for the first time on TVA work, a dinner, and then the "Lady of the Lake" ball.

The Mexican government has taken possession of the Kansas City, Mexico & Orient Ry., which it recently purchased from private interests.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern engineers and contractors

Water and War

Sir: I have read the article on sabotage of water supply with a great deal of interest. It covers the field pretty fully without going into what might be said to be "alarming detail".

One of the great problems is the unwillingness of many cities to provide funds necessary for protection. Such funds may amount to very considerable sums. I have always felt that provision should be made for temporary pumping equipment and emergency chlorine facilities. Both of these are equally essential and yet their provision might involve a vast sum of money. In open reservoirs not subject to secondary chlorination, the danger of bacterial infection is very great. The introduction of virulent cultures of pathogenic organisms would be comparatively simple but fraught with considerable danger to the consumer. Due to dilution, I do not think much danger exists of chemical poisoning. It has been pointed out that even with an efficient patrol of reservoirs, cultures could be dropped from the air or even shot into the water by means of a bow and arrow. Let us hope that no brutal action of this kind will be attempted.

NORMAN J. HOWARD
President
American Water Works Association
Toronto

Sir: In your article on sabotage and water service you have covered the field pretty thoroughly, and I think that your suggestions for specific measures are going to be of great value to the waterworks men.

Probably you will receive communications from various waterworks authorities, giving some detailed information as to the specific measures which they have incorporated in their program of preparedness. Would it not be practical to establish some form of clearinghouse for this type of information, possibly issuing a confidential bulletin each month to all waterworks superintendents in the United States?

One point which I think you might bring out in your article is that the many industrial plants which are located on the banks of rivers or streams should consider the installation of pumping equipment of their own for furnishing water for fire protection and processing work. Such a measure would make them fairly independent of the continuity of the municipal water supply. Another point which might be well worth while considering is that of interconnection between adjoining waterworks.

S. A. CANARIIS
Waterworks Engineer
Pomona Pump Co., New York

Sir: A year ago your report would have seemed quite visionary; but the events of the past ten months have shown that the most unlikely things may come about. Furthermore, I feel quite strongly that if we are to avoid surrender to the principles of the totalitarian states, either as a result of force from without or from the turn of events from within, we must initiate our own preparations for the defense of the country. It is much better for the waterworks men to initiate their own protective measures than to have measures which might be inappropriate forced upon them.

E. SHERMAN CHASE
Metcalf & Eddy, Consulting Engineers
Boston, Mass.

Sir: It is probable that two types of sabotage to water service will come to light. One will be of a more or less freakish and scatterbrain type while the other will be the result of a scientifically planned scheme to make trouble. The vulnerability of the water system should be considered from both of these angles. I would think it advisable to accent the consideration of such equipment as would be difficult to replace due to its special nature. There are generally one or more items of special equipment, outside of stock apparatus, which, if damaged, would embarrass the water service for a considerable length of time. It may be difficult to persuade municipalities that even this special apparatus should be duplicated as soon as possible so that it would be available in case of damage to similar equipment now in operation.

I think that the commission, committee, or individual entrusted with providing safeguards should first devote a little time to a detailed consideration of the most vulnerable points in the system as it now exists and attempt to determine the weak link. The agencies of sabotage will undoubtedly know this weak link and the municipality should give an equal amount of study to the location and character of such a vulnerable point in the system.

HENRY W. TAYLOR
Consulting Engineer
New York City

Sir: I heartily agree with you as to the necessity of calling to the attention of all waterworks officials this matter of possible sabotage, and you certainly have handled it in an excellent and very sane manner.

As would be expected in connection with a system as large and as completely organized as is the Chicago water supply, the majority of the safeguards recommended in your article are already carried out as routine matters. Nevertheless, we are taking every precaution to protect our system.

LORAN D. GAYTON
City Engineer
Chicago, Ill.

Sir: Reports from abroad indicate that sabotage of water service is easier and more effective from within than from the outside. Experience indicates, therefore, that the key of the situation is: responsible and dependable personnel. Scrutiny of employees as recommended in your article is of major importance.

In this country it is customary and encouraged to have visitors at the plants to build up good will. This system is entirely different from abroad where, as a rule, visitors without proper introduction or written permission are not allowed to enter. The practice to allow visitors to wander through a plant and encourage their questions may be an added hazard, but is of less importance than leaving the plant open to any uninvited guest who may enter whenever he pleases.

W. Rudolfs
Chief, Department of Water and Sewage Research
New Jersey Agricultural Experiment Station, New Brunswick, N. J.

Card Index for Articles

Sir: I keep my copies of *Engineering News-Record* in numerical order and at the same time maintain a small card index and cross-reference system which I keep up to date. This is under the general engineering headings, excavation, highways, bridges, dams etc., with the result that these back copies provide an excellent reference library for research work.

On two occasions I have quickly furnished material for a public address by merely checking back under the heading of "California", for example, and then running down public improvements. The same is equally applicable should an engineer desire to prepare a paper on "Modern Concrete Construction" or a hundred other kindred subjects.

Hal Clark Sanborn
Civil Engineer
Ocean Park, Calif.

Negotiated Contracts

Sir: Two conclusions reached by Louis B. Wehle in his article entitled "Construction Contracts for Defense" (*ENR* Aug. 1, 1940, p. 155) are not confirmed in my experience and judgment:

(1) A negotiated fee contract is based upon estimated quantities and costs. If the project is enlarged or reduced, the fee can be adjusted. If the cost of the project is increased or decreased by change in labor rates, material prices or other construction reasons, the fee is not changed. The increase or decrease in the scope of the work can be determined under very much the same regulations as the increase in the scope of the work was determined under the standard form of government contract.

(2) While there may be some types of contracts where it is to the advantage of the project for the government to buy the materials, in most instances a contractor can more accurately plan his work if he is charged with the placing of orders for materials. In theory the government could buy the materials, subject to shipping instructions from the contractor. In most instances, however, it is more satisfactory for the contractor to be in control of both the purchasing and shipments. It is often necessary to buy miscellaneous materials to carry on a job, which should be purchased through a field office. If contracts are given to contractors familiar with local conditions, such contractors know the sources of supply of various materials and are in a better position to place the orders to fit in with the available sources of supply.

It is unquestionably of importance to the construction industry that so-called emergency contracts be handled to avoid subsequent reflection on the contractors who perform these contracts. On the other hand any contractor who undertakes emergency work must expect criticism, and unless the criticism is justified the contractor should go ahead with courage, skill and integrity to perform the job entrusted to him.

Oscar B. Coblentz
President, McLean Contracting Co.
Baltimore

Trained Welders Necessary

Sir: In the letter by J. F. Lincoln (*ENR* May 23, 1940, p. 702), in which he described the simplicity of the arc welding process, I feel that he has gone just a bit too far in minimizing the importance of trained operators. He is undoubtedly referring to large plants that have used welding for a long time and have highly developed procedure control when he says, "The only thing that a welding operator can do is to hold the end of an electrode at a certain distance above the deposited metal and advance it along the seam to be welded at a certain speed. There is nothing more than that involved in this operation. It is neither complicated nor difficult." It seems to me that airplane manufacturers might just as logically advertise that, "The only thing that a pilot can do is to move the stick, push the rudder bar and give the engine the gun. There is nothing more than that involved in this operation. It is neither complicated nor difficult."

Responsible for distribution of a well-known line of arc welding equipment, I've been travelling about 30,000 miles annually for several years throughout the United States, Canada and Mexico, in order to get first hand information. Naturally, that has brought me into personal contact with large and small users of arc welding in various industries and I do not believe a large percentage of them would be any more interested in trusting their welding to inexperienced or untrained operators than in starting a flight across an ocean with an untrained pilot. True, there have been remarkable developments and improvements during recent years with respect to equipment, methods and materials involved in arc welding. The process has unquestionably been greatly simplified but I do not believe this condition should be exaggerated.

Contact with large users and with American Welding Society sections has given me the impression that there is more and more attention being paid to qualification of operators as well as of methods and materials. It seems to me that it would be better for all concerned to admit that best results from arc welding call for its use by skilled operators. In the textbook used at our factory-operated, non-profit welding school we say: "Anyone with average intelligence, a steady hand, and a real desire to perfect himself in the art can readily learn to weld with the electric arc. To become an expert operator, however, requires something more than mere ability to manipulate the welding arc."

Continuing the quotation from our textbook: "The man who has had previous training and experience in some mechanical trade will develop more quickly into a proficient welding operator than the man without such training or experience. An experienced gas welder will find it extremely easy to become proficient with the arc due to his knowledge of metals, welding heats, etc." In other words, while admitting the desirability of using trained operators, we try to point out the fact that it is not difficult to develop them, if none are available to the employer planning to adopt arc welding. Even where procedure control is so far advanced that little is left to the discretion of the welding operator, I personally believe that better welding may be expected when the operator knows "what it is all about".

W. J. Chaffee
Welder Division
The Hobart Brothers Co., Troy, Ohio

ENGINEERING NEWS-RECORD

Copyright 1940, by McGraw-Hill Publishing Company, Inc.
Volume 125, Number 7
F. E. Schmitt *and* Waldo G. Bowman, *Editors*
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Editorial Offices at 330 West 42nd Street, New York
August 15, 1940

UNDER EMERGENCY CONTRACTS worked out by the Army and Navy for defense construction, abstracted on another page, complete cooperation of the parties to the contract is aimed at. The details of the contract provisions are to be appraised by the test of how effectively they bring together the government's knowledge of objective and means and the contractor's organization and skill in overcoming field difficulties. By coincidence, this week's news of the outstanding success achieved under the Navy contract in building the Pacific bases gives reason to believe that the high-pressure construction work of the Army will show equal success in overcoming all obstacles to rapid completion. While the Army contract differs in many provisions from that of the Navy, the fundamental need for cooperation with the contractor is precisely the same. Some provisions of the Army contract remain to be tried out in practice, especially the unusual wage-payment clause, which may easily put the contractor in the hole. But contract details can and no doubt will be revised when necessary. The vital element is the spirit of the contract; the aim to bring about complete and close working partnership between government and contractor.

Colored Slow Lanes

NO ONE who has crawled up a hill behind a loaded truck needs to be told how traffic is slowed up by inability to pass on a narrow and generally winding hill road, nor does such a driver need to be told of the high accident rate on such hills. Widening on hills has been practiced in some places, but hill roads quite generally remain a source of delay and danger. To meet this condition Tennessee is experimenting with the addition of a third lane of colored concrete at the right of the up lane on a long hill north of Nashville. Signs at the foot direct truck traffic into the red lane. The use of colored concrete has two advantages; it makes the slow lane distinctive and so aids in getting compliance with the special traffic rules for the hill; also, it makes no break in the visual continuity of the two-lane road and so minimizes the risk that is involved when drivers coming down the hill use the center strip as a passing lane. Actual operating results will be watched with interest by all highway engineers faced with the hill problem.

Time to Reflect

FIRE-LAW VIOLATION by a tenement house owner recently earned him a six-month jail term. He had failed to install fire-retarding walls in hallways, and when a fire broke out several lives were lost; now he has six months' time to reflect on the disadvantages of subjecting other people's lives to prohibited risks. It would be well if city officials and the people at large also took time to reflect on the perpetuation of unnecessary fire dangers. Violation of safe building rules and of fire-protection laws is common. Official determination to clean up bad building conditions and vigorous public support of such a campaign would aid in reducing deaths from fires or building collapse.

New Frontiers

NEED for a realistic approach to problems presented to most cities by population movement is urged in this issue by Emerson Goble, editor of the National Real Estate Journal. His comment calls for thoughtful consideration by municipal engineers and city plan commissions. Mr. Goble does not believe in decentralization and he has no patience with those who accept the population exodus and the expanding blighted areas in our cities as inevitable. People would like to live close to the centers of business and pleasure, he says, and will live there if they are made attractive. That calls for much drastic replanning and reconstruction, all of which Mr. Goble holds to be as challenging as any new frontier ever was. It is a challenge. It cannot be met by the visionary type of planning that has characterized too much planning of the past. It must start with property use studies and must be implemented by legislation that will make possible the wholesale reconstruction of some areas or the entire cleaning out of others. Here truly are new frontiers of municipal legislation and finance that must be explored and developed if untold assets in property and municipal services are not to be lost through slow decay.

Engineering Council

ANNOUNCEMENT that the American Society of Civil Engineers will withdraw from American Engineering Council turns a spotlight on the failure of engineers to organize and maintain effective representation in the nation's capital. The idea back of Engineering Council was good, but early in its career its administrative officers tied it so tightly to the political kite of its first president, Herbert Hoover, as to ruin its effectiveness as a non-partisan agency. The council never fully overcame that handicap.

An added factor that seriously reduced the effectiveness of Engineering Council was the failure of the civil engineers to come in at the start and, in more recent years, their long dithering on the brink of withdrawal. Without doubt another weakening factor was the council's lack of interest in the professional groups such as the American Association of Engineers and the state societies that now make up the National Society of Professional Engineers.

All this is not to say that American Engineering Council has not done useful things in the 20 years of its life. It has, but the cost has been high, and most, if not all, could have been done equally well by one of the Founder Societies.

What of the future? Many engineers favor complete abandonment of American Engineering Council; others favor transfer of its functions to the National Society of Professional Engineers, which now represents 6,000 engineers in Washington. Out of the confusion nothing stands forth clearly except the fact that the interests of engineers in Washington are too diverse to be handled by a single agency if that agency is to attempt to develop policies and speak for engineers as a group, much as the council attempted to do.

But the answer does not appear to lie in complete abandonment of some central agency such as American Engineering Council. There still is need for a sort of listening post where legislation can be examined as it is dumped into the Congressional hopper so that matters of possible interest to engineers can be reported to the group most directly concerned. This agency would report on progress of legislation in Congress, would keep in touch with federal departments to learn what they are doing that might interest engineers and would be available to aid engineers in finding their way around the maze of federal bureaus. It would differ from A.E.C. in that it would not act as spokesman for any of the supporting organizations.

In theory, such a service could be rendered by the headquarters of the National Society of Professional Engineers; but as a practical matter that organization is so young and so lacking in national acceptance as to make that suggestion questionable. Also, as that organization aims to be a factor in national matters of interest to engineers it labors under some of the same handicaps that made A.E.C. ineffective.

American Engineering Council attempted to be eyes, ears and mouth for engineers in the nation's capital. It proved ineffective and even harmful as a mouthpiece. Before it is abandoned, it should be permitted to demonstrate what it can do in the way of keeping engineers informed as to what it sees and hears in Washington.

Great Work

A BRILLIANT EXAMPLE of driving power in defense construction was made public by the Secretary of the Navy this week when he announced that work on mid-Pacific navy bases, begun barely a year ago, is far ahead of schedule and is well along to completion. The contract had fixed unusually short time schedules, under pressure for earliest possible results. Yet Kaneohe base, for example, will be completed by December, ten months earlier than contract date, and the others are moving along at almost equal speed.

Nearly a year's time has thus been gained in giving us better protection. Hats off to the men behind this accomplishment! Admiral Moreell, planning and directing genius of the work, and the contracting group that carried it out—Hawaiian Dredging Co., Turner Construction Co., and Raymond Concrete Pile Co. jointly—are entitled to the country's gratitude.

The story of the accomplishment in detail must wait until later. The work had to be done in the wide-open spaces of the Pacific, far from a base of supplies, and from a standing start. Equipment, materials and supplies were at the end of a long ship route. To cope with these conditions required thorough planning, carefully studied and unsparing provision of plant, and coordination of all operations. Much credit must be given to the type of contract, a fee contract so written as to establish an effective partnership between government and contractor. But no contract is better than the spirit of the men who carry it out.

The work out in the mid-Pacific proves that the construction industry is ready to do its part in the defense program.

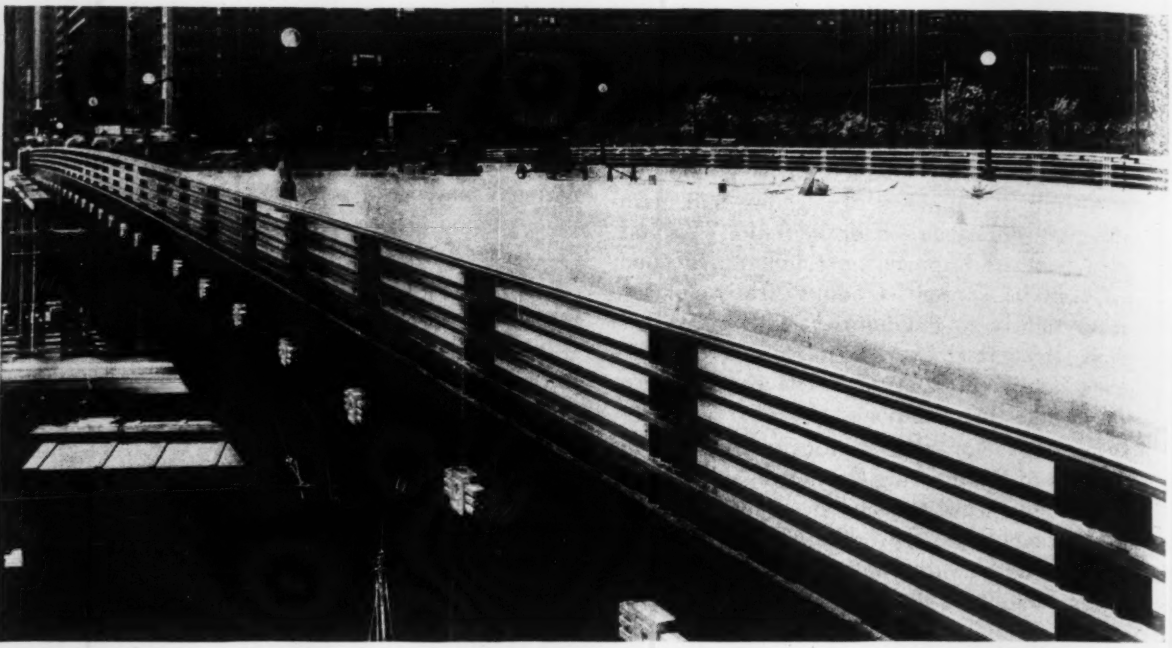

FIG. 1. CAST-IRON FASCIA PLATES AND ROLLED STEEL HANDRAILS PROVIDE EFFECTIVE ARCHITECTURAL TREATMENT.

Bridging Busy Electrified Tracks

LAWRENCE T. SMITH, and LYMAN C. RIGGLE
Resident Engineer Structural Designer
Chicago Park District

***Contents in Brief**—An obsolete viaduct over the busy electrified tracks of the Michigan Central and Illinois Central railroads is replaced with little interference to railway traffic during construction. Chicago park engineers use foundations of old structure, and increase roadway width from 34 to 60 ft. by means of a cantilevered deck. In the new design pinned hangers are used at expansion joints. A grid-type deck, filled with concrete, reduced the weight to 55 lb. per sq. ft.*

PINNED HANGERS at the expansion joints of the girders, a deck that is considerably wider than the foundations, a concrete-filled steel grid roadway, cast-iron ornamental fascia plates and rolled steel ornamental railings (Fig. 1) are outstanding features of a new viaduct constructed by the Chicago Park District in Grant Park. This viaduct replaces an obsolete Monroe St. crossing built in 1913 to span the tracks of the Illinois Central and the Michigan Central railroads.

The old viaduct, a 6-span structure with steel girders encased in concrete, had a 4-ft. longitudinal crown between abutments, approach grades as great as 11 per cent, and a 34-ft. roadway, which created a bottleneck at times of peak traffic. The five intermediate steel bents, supported on piling, with a maximum pile load of 20 tons, were protected by concrete collision piers up to a height of 5 ft. above track level. Since the bents had to be accommodated to the track layout some of them are skewed with respect to the bridge centerline. The existing abutments were supported on earth; the west one was of masonry in good condition, and the east of concrete with upper portion badly disintegrated. To cause the least interruption of railroad traffic, it was decided to use the old foundations for the new structure, which is 282 ft. long by 85 ft. wide. This structure provides a 60-ft. roadway with a longitudinal crown of 2 ft. and a maximum approach grade of 4.4 per cent.

The construction plan required routing vehicular traffic via other bridges, providing a temporary pedestrian crossing, and protecting railroad operations during construction by the use of heavy timber canopies.

Old piers used

The design adopted called for cutting off the steel columns of the five intermediate steel bents at a point 3 ft. above the old concrete collision piers and then carrying the concrete to the full height, the column stubs to act as dowels between the old and new construction. The west abutment was cut down to the old bridge seat and the east abutment down below the damaged concrete, the upper portions of each abutment then being rebuilt.

Design live load on the new viaduct was for a 24-ton truck surrounded by a uniform live load of 100 lb. per sq.ft. on the roadway and sidewalks, plus 30 per cent for impact. With this load, and with spans varying from 40 to 55 ft., it was found possible, for the most part, to use 30-in. rolled beams on 6-ft., 2-in. spacing for the floor system. Concrete encasement of these beams was dispensed with since there is very little steam traffic under the viaduct.

Because of the shallow depth of the beams, continuity was desirable over the entire six spans. This was obtained by the use of pinned hangers (Fig. 3) at two expansion joints, the hangers permitting transfer of end reactions of the girders without transfer of bending moment. The hanger pins are made of chrome-nickel steel, the girders with which the pins came in contact, as well as adjacent unpainted areas, are protected by a ⅛-in. sheet of chrome-nickel steel fillet welded in place.

Unusually light flooring

In keeping with the need to reduce the weight of the superstructure as much as possible, a 4¼-in. steel grid deck welded to the girders and filled with concrete was used. A floor weighing but 55 lb. per sq.ft. resulted. The method of obtaining extra roadway width by cantilevering past the pier edges is shown in Fig. 3. The steel finger castings used for the expansion joint are illustrated in Fig. 4, ample clearance being allowed in these joints and special care being taken to provide for drainage. Smoke protection for the underside of the viaduct consists of planks bolted to the lower flanges of the girders and covered with No. 4 sheet lead. To assist ventilation, the pans under the deck are arched more than usual and grilles are provided in the cast-iron fascia plates.

Ornamental treatment

These cast-iron fascia plates and rolled steel ornamental handrails are utilized to secure a pleasing appearance for the structure. For additional architectural effect, the plates and handrails terminate at each end of the viaduct in approach wing walls faced with black granite. Illumination is provided by cast-iron and concrete lamp posts spaced about 90 ft. apart, cast iron being used on the

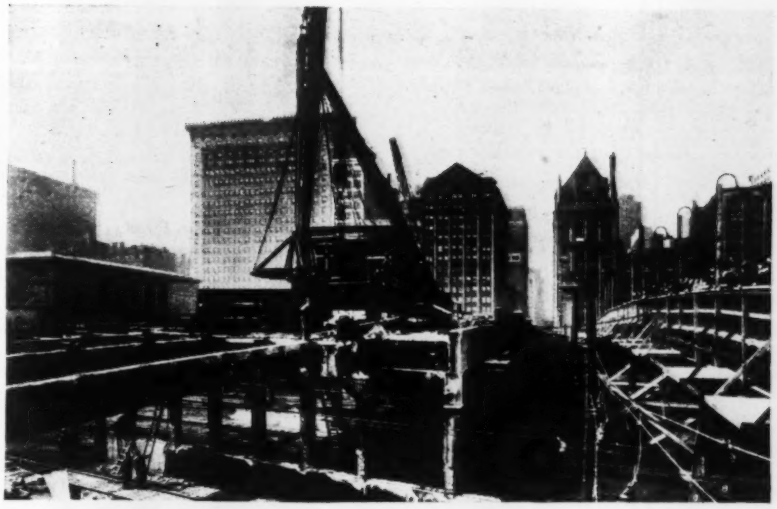

Fig. 2. Removal of old girders called for cutting the larger ones into sections because of excessive weight. Temporary crossing for pedestrians at the right.

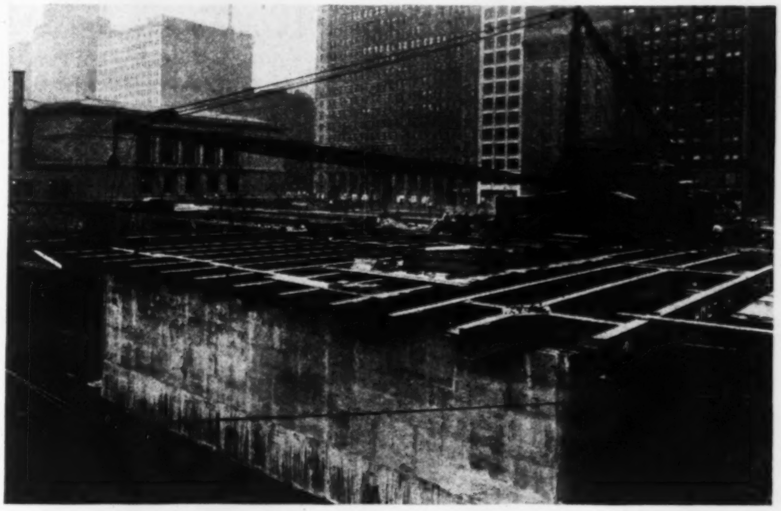

Fig. 3. New girders are continuous with pinned hangers at the two expansion joints. Note method of cantilevering beyond old pier edges to gain roadway width.

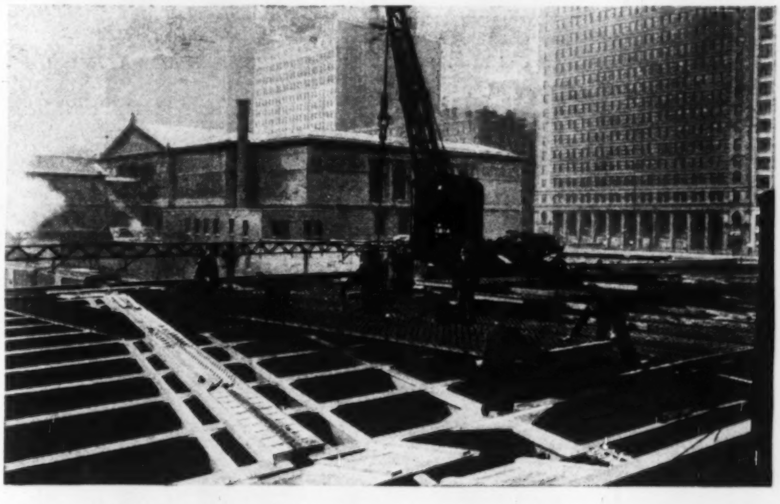

Fig. 4. Skewed piers account for diagonal expansion joints.

viaduct proper and along the west approach, and concrete posts on the east approach. One 6,000-lumen lamp is provided at each post supplying more than ample illumination.

Construction work

The demolition of the old bridge and construction of the new crossing was carried out with a stiffleg traveler derrick equipped with a 90-ft. boom. In the demolition work, the derrick backed across the viaduct, progressively removing the old spans; at the same time the old substructure was rebuilt to carry the new bridge. In erecting new steel the derrick moved forward across the bridge in the opposite direction. The longest girder placed for the new viaduct was 108 ft. and the shortest 80 ft.

For demolishing the old deck slabs and girder encasement a skull-cracker from the stiffleg derrick supplemented by concrete breakers proved valuable. Each slab panel was first removed, then the encased beams (after being cut at the edge of the girders), and finally the girders. In the latter work, the short members were removed as one piece but the longer spans had to be cut into sections, the maximum load being 35 tons, with the average about 20 tons.

Safety devices

In order to protect railroad facilities during the work, a heavy wooden canopy was suspended from the old steel frame by 1-in. manila rope slings; rope was used because of the electrical hazard, as in many places the canopy was in direct contact with catenary messenger cables carrying 1,500 volts. At such points, all cables were blanketed with rubber hose and rubber blankets. In addition, the Illinois Central maintained the necessary electrical crew and safety men on hand at critical times.

Direction

The work, costing $235,000, was carried out in 278 days by the Ketler-Elliot Co., general contractors of Chicago, as a PWA project with a 45 per cent grant. For the PWA, Byron K. Coghlan was resident engineer-inspector, D. R. Kennicott, regional director, and G. L. Rounds, regional engineer. For the Chicago Park District, Lyman C. Riggle was in charge of design, W. R. Weigler, architectural treatment, and Lawrence T. Smith, field supervision.

Red Concrete for Slow Traffic

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TO PROVIDE AN OPEN ROAD for fast cars, while heavy trucks slowly climb a hill on a main road about 15 miles north of Nashville, Tenn., the engineers of the Tennessee highway department constructed a third lane, and to make sure that trucks would follow it, paved it with red concrete. The operation involved straightening an old bituminous-macadam road that wound dangerously up the side of a ridge. By blasting out several deep rock cuts, it was possible to save about 1 mile in 1.876 miles of new construction.

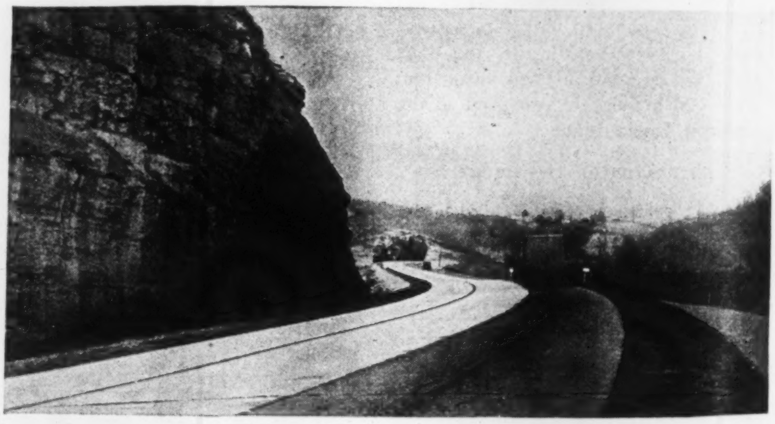
Traffic analysis indicated that the road at this point carries a heavy truck load north into Kentucky. (Traffic count, 1,200 vehicles per day, of which 400 are trucks and buses.) Since the grade varies from 5.5 to 6 per cent and for the entire length is a series of horizontal curves limiting the sight distance, it was apparent that on a two-lane road, which would have been adequate under ordinary conditions, fast traffic would pile up behind the slower trucks. This in turn would inevitably lead to accidents when impatient drivers tried to pull around the trucks in the face of down-grade traffic.

The obvious solution to this problem was an extra slow-traffic lane on the right-hand upgrade side. However, some means had to be devised that would keep slow traffic on this lane. After considerable laboratory research, it was decided to construct the extra lane of concrete colored with red iron oxide.

The paving contract was let to the Municipal Paving & Construction Co. of Nashville, and two 11-ft. 8:6:8 in. regular concrete slabs, with expansion joints at 90 ft. and contraction joints at 30 ft., were put down over the length of the relocation. Then, beginning at the bottom of the grade, an extra 11-ft. slow-traffic lane was put down paralleling the regular lanes for 6,000 ft. to the top of grade. This 11-ft. lane was designed with only half the superelevation used on the fast lanes.

Regular concrete was placed to within 2 in. of the desired slab thickness. Immediately thereafter, the red iron oxide was added to the concrete in the mixer (4 lb. per sack of cement) and the top 2 in. of red concrete was placed. In order that the regular concrete would not come up through the red concrete, care was taken not to agitate the top course although every effort was made to achieve maximum density. Finishing operations were the same as for regular concrete.

The project was completed in Aug-



Slow-traffic third lane of red concrete allows trucks to take their time in hill climbing while light cars have a clear two-lane road for extra speed and safety.

ust, 1939, at a total cost of $58,-759.60. The additional cost of the red concrete was about 15¢ per sq.yd.

At the foot of the grade a large sign on the pavement directs slow traffic over into the red lane. In observing the road for two hours, no slow trucks failed to pull over into the red lane. Fast cars kept in the regular right-hand lane and did not attempt to pass other vehicles before honking them over into the red lane. So far as the writer knows there have been no accidents since the road was opened. In all probability the state will build more of these roads.

A New Pipe Formula

LELAND S. RHODES

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Pennsylvania State College

IT CAN BE SHOWN that the usual pipe-friction formula for loss of head expressed as a function of Reynolds' number is somewhat in error because it does not take into account Froude's number also. Beginning with the fundamental formula,

$$h = f \frac{L}{D} \frac{V^2}{2g} \qquad (1)$$

in which h is the loss of head; f a dimensionless coefficient, L the length, D the diameter, g the acceleration due to gravity, and V the velocity, it will be shown that a good formula to use for a large range of pipe sizes and for a variety of fluids would be

$$h = 0.212 \frac{L}{D} \frac{V^2}{2g} \frac{N_F{}^{0.04}}{N_R{}^{0.19}} \qquad (2)$$

in which N_F is Froude's number or $\frac{V}{\sqrt{gD}}$ and N_R is Reynold's number or $\frac{VD\rho}{\mu}$, ρ being the density and μ the absolute viscosity. This can be shown as follows:

Assuming that the frictional loss varies not only with length, diameter, velocity, and acceleration of gravity, but also with viscosity and density of the fluid flowing, let

$$h = k\, L\, D^a\, V^b\, \mu^c\, \rho^d\, g^e \qquad (3)$$

in which k is a dimensionless quantity and the exponents a, b, c, d, and e are to be determined by dimensional analysis. Equating the dimensions of the quantities in Equation (3), we get

$$L = L\, L^a\, \frac{L^b}{T^b}\, \frac{M^c}{L^c T^c}\, \frac{M^d}{L^{3d}}\, \frac{L^e}{T^{2e}} \qquad (4)$$

in which L, T, and M indicate dimensions of length, time, and mass.

Equating the power of length on the two sides of Equation (4) and then doing the same for time and mass, it is possible to write, for length $1 = 1 + a + b - c - 3d + e$, for time $0 = -b - c - 2e$, and for mass $0 = c + d$. Although we can not obtain numerical values for the unknowns from the above relationship, because there are more unknowns than equations, we can write $d = -c$, $b = -c - 2e$, and $a = -c + e$. Substituting these values in Equation (3) and grouping like powers, it follows that

$$h = k\, L \left(\frac{V^2}{gD}\right)^{-e} \left(\frac{V\,D\rho}{\mu}\right)^{-c} \qquad (5)$$

or

$$h = k\, L\, N_F{}^{-2e}\, N_R{}^{-c} \qquad (6)$$

Equation (6) shows that the friction loss per foot of pipe depends on both Froude's number and Reynolds' number. Assuming that $e = -1$, then Equation (5) would reduce to

$$h = 2k \frac{L}{D} \frac{V^2}{2g} N_R{}^{-c} \qquad (7)$$

which is the usually accepted result. However, available experimental data seem to indicate that e is not equal to minus one, as will now be shown.

The generally accepted Hazen & Williams equation for flow of water in clean cast-iron pipes of the usual range of diameter and velocity (See Williams and Hazen, Hydraulic Tables, p. 1–3) is

$$V = 130\, R^{0.63}\, S^{0.54}\, 0.001^{-0.04} \qquad (8)$$

in which, for a circular pipe, R is the hydraulic radius or $\frac{D}{4}$, and S is the slope or $\frac{h}{L}$. Equation (8) is therefore equivalent to

$$h = 0.0235 \frac{L}{D^{1.167}} \frac{V^{1.851}}{2g} \qquad (9)$$

Substituting this value for h in Equation (1) the value of f is given by

$$f = 0.0235\, D^{-0.167}\, V^{-0.149} \qquad (10)$$

Prof. E. W. Schoder gives for "fairly smooth pipes" the equation $h = 0.00038 \frac{LV^{1.86}}{D^{1.25}}$ (See Schoder & Dawson, *Hydraulics*, p. 216) and the corresponding value of f is given by

$$f = 0.0245\, D^{-0.25}\, V^{-0.14} \qquad (11)$$

Taking a fair mean between Equations (10) and (11) we can write

$$f = 0.024\, D^{-0.21}\, V^{-0.15} \qquad (12)$$

Equation (6) can be written

$$h = 2k \frac{L}{D} \frac{V^2}{2g} N_F{}^x\, N_R{}^y \qquad (13)$$

in which $x = -2\,(1+e)$ and $y = -c$. Also equation (13) is equivalent to writing

$$f = 2k\, N_F{}^x\, N_R{}^y \qquad (14)$$

or, substituting the expressions for Reynolds' and Froude's numbers,

$$f = 2k \left(\frac{V}{\sqrt{gD}}\right)^x \left(\frac{VD\rho}{\mu}\right)^y \qquad (15)$$

Equating values of f given by Equations (12) and (15) we have

$$2k\left(\frac{V}{\sqrt{gD}}\right)^x \left(\frac{VD\rho}{\mu}\right)^y = 0.024\, D^{-0.21}\, V^{-0.15} \qquad (16)$$

Equating powers of D in Equation (16), and doing the same for powers of V, we get $-\frac{1}{2}x + y = -0.21$ and $x + y = -0.15$ or $x = +0.04$ and $y = -0.19$. Substituting these values for x and y in Equation (13) the value of h becomes

$$h = 2k \frac{L}{D} \frac{V^2}{2g} \frac{N_F{}^{0.04}}{N_R{}^{0.19}} \qquad (17)$$

In order to get a value for $2k$, we must assume probable values of μ and ρ for the water that was tested to obtain equation (12). Using $\mu = 0.0000295$ slugs per foot-second, and $\rho = 1.94$ slugs per cu. ft., we get from equation (16) and the known values of x and y, $2k = 0.212$; and so

$$h = 0.212 \frac{L}{D} \frac{V^2}{2g} \frac{N_F{}^{0.04}}{N_R{}^{0.19}} \qquad (18)$$

This should be a good formula to use for quite a large range of conditions. Also, although better equations are expected with continued research, Equation (18) shows that the fact must be kept in mind that Froude's as well as Reynolds' number has some bearing on pipe friction.

Wichita Makes Cast-Iron Water Line History

Contents in Brief—The largest cement-lined, centrifugal cast-iron pipe yet made, 48 in. in diameter, and the first pipe of such size to be designed for exact load conditions, external as well as internal, is being used in a new 30-mile water supply line at Wichita, Kan. Involved in the project are also a new groundwater supply, free from the mineral and chloride content of the existing supply, and a new filter plant. Extra care in trenching and laying was necessary to assure the support conditions assumed in the design.

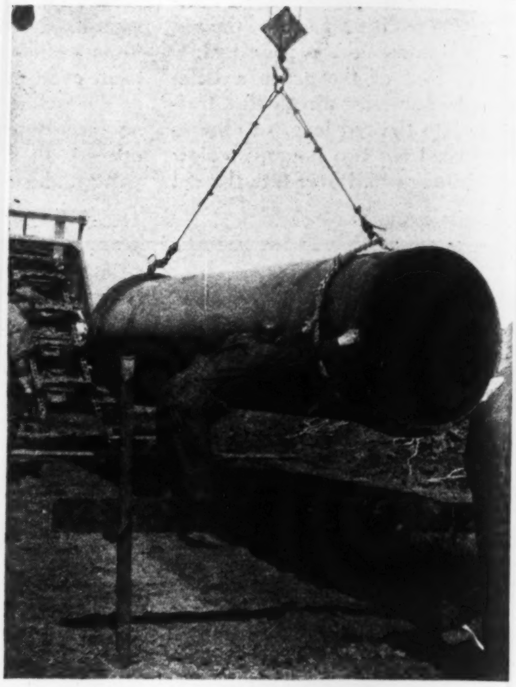

Fig. 1. Lowering a 48-in. cement-lined, cast iron pipe section weighing 4 tons into the machine-cut trench.

Quality more than quantity was what Wichita sought when it went some 30 miles out on the prairies to develop a new well water supply that will be flowing to the city about Sept. 1 through cement-lined cast iron pipe, notable for its 48-in. maximum diameter, the largest centrifugally cast pipe yet manufactured and the first of this size to be produced under the "new law of design" that takes scientific account of external as well as internal loads.

Water quality has double meaning for this Kansas city of 115,000 population. It is important to the domestic user, of course, but it is vital to industries, of which Wichita has many. Quality in this case means freedom from the high mineral and chloride content of the present privately owned supply that is taken from a group of shallow wells penetrating the underflow of the Arkansas and Little Arkansas rivers in the city. For human consumption this present supply is potable, if not entirely satisfactory, but it penalizes and stunts the growth of industry. And Wichita, which had airplane factories before Baltimore, Los Angeles and Seattle, and is the site of flour mills, meat packing plants and other establishments that flourish in an agricultural environment, wants to grow industrially. The $2,425,000 investment in the new water supply is largely based on the hope of industrial dividends.

What is involved

The new water supply project consists of three major parts:

(1) A new groundwater supply of 32 million gallons per day from 25 wells, in a water-bearing formation about 30 miles northwest of this city.

(2) Gathering lines from the wells in the supply field, and a supply main from these gathering lines to Wichita.

(3) A 32-mgd filtration plant located in Wichita near the existing plant of the private Wichita Water Co., which will distribute the new supply. Principal purpose of the plant is to remove 1 ppm of iron and treatment will consist of coke tray aeration, lime treatment, coagulation, filtration and chlorination.

The location of the various elements of the project is shown in Fig. 2. The aquifer which the wells penetrate consists of alternating layers of sand and clay overlying shale at depths from 150 to 250 ft. and with the static groundwater level very near the ground surface. The wells are of the gravel wall type—30-in.-diameter holes and 18-in.-diameter casing. Shallow wells were constructed by the casing method and the deeper ones by rotary drilling. A minimum spacing of about one-half mile between wells is maintained, and the wells intercept a front of about nine miles perpendicular to the direction of the groundwater flow. Twenty-two of the wells are equipped with 1,000-gpm vertical turbine type pumps and three with 500-gpm pumps.

Principal interest in the new supply centers in the cast iron supply main, made up of the following sizes and lengths of pipe:

48 in.	93,100 ft.
42 in.	27,200
36 in.	8,200
30 in.	7,300
24 in.	7,800
20 in.	5,300

In addition there is 25,400 ft. of 14-in. cast iron pipe in the gathering lines. All told, this adds up to 27,000 tons of pipe of which the 48-in. size accounts for 20,000 tons.

Available head differential between the wells and the filter plant is 90 ft., which is adequate for handling normal demands by gravity flow, although some help will be required from the well pumps to meet maximum demand. The well pumps are designed to supply the maximum capacity of the filtration plant.

Among the important auxiliaries are two automatically operated and controlled cone valves, one located near the center of the well field and the other at the filter plant, whose purpose is to keep the line full of water at all times to prevent entrance of air, and in the case of the lower valve to regulate flow to the filters. In addition four manual cone valves between the wells and the filter plant divide the line into five sections. Other valves are installed for pressure relief, air and vacuum release and for blowoff purposes.

Pipe designed for actual loads

The design of the cast iron pipe for the line was based on the principles given in part 1 of the "Manual for the Computation of Strength and Thickness of Cast Iron Pipe," which involves a new theory and method of design developed by Sectional Committee A21 of the American Standards Association. In addition to static pressure, water hammer, foundry tolerance and corrosion factors, the design computations include the external loads imposed by earth pressure and trucks and the effect on such external loads and the resulting stresses in the pipe barrel of different methods of pipe laying, bedding and tamping.

This new method enables the engineer to specify pipe of an adequate but not excessive thickness, instead of being restricted to the thicknesses of the few standard classifications of pipe. The old methods of pipe classification, being based largely on internal working pressure, required that all pipe within the class pressure limits be of the thickness necessary for the maximum pressure condition encountered, even though most of the line might be subjected to a much lower pressure. Also the external loads assumed under these older methods were based on ordinary distribution system service and thus were excessive for shallow cross-country lines while they were entirely inadequate for large diameter pipe subjected to low internal pressure and heavy superimposed loads. The usual practice of many designers and specification writers has been to ignore external loads entirely, a procedure satisfactory enough for small diameter pipe but rather dangerous for large pipe.

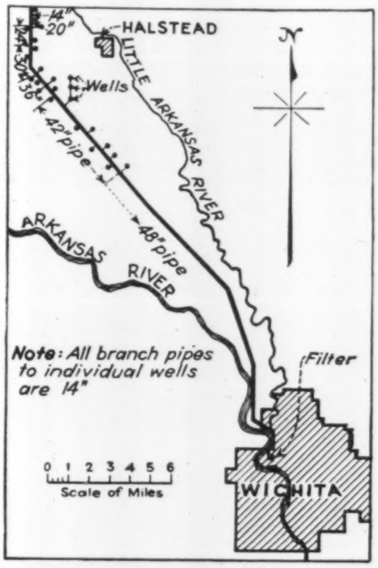

Fig. 2. Alignment of the 30-mile line that brings a new groundwater supply to Wichita.

On the Wichita line the pipe was classified for internal working pressures as Class 50, 75 and 100, the figure in each case representing the water working pressure in pounds per square inch. For external loads the pipe was classified as standard, Class 3.5 and Class 5.0, the figure representing the depth of earth cover over the pipe; for "standard" this is assumed to be 2½ ft. or less. Dead loads were based on assumptions of a flat bottom trench and tamped backfill, and trenching and pipe laying specifications were written to insure this condition.

Live loads were divided into two classes, "standard" and highway or "X." The standard classification includes all pipe laid across fields and open country outside of highways, streets, and railroad rights-of-way, except that in certain locations, where the depth of cover exceeded 5 ft., the highway classification was used to avoid an additional classification for a very small amount of pipe. The "standard" live load is imposed by a 6,000-lb. wheel load which, with 80 per cent rear axle load distribution, would be that imparted by a 5-ton truck with a 50 per cent allowance for impact or a 7½-ton truck with no impact allowance. The highway live load is a 15-ton truck which would give a 12,000-lb. rear wheel load, assuming 50 per cent impact. Such a heavy load was considered advisable because of the heavy trucking incident to local oil field operations. By its use differences in pipe thickness, occasioned by varying depths of cover from 2½ to 6 ft., were so small that it was not considered necessary to provide different depth classifications for the small amount of highway location required.

Usual design practice is to take account of either water hammer or truck loads, whichever is greater. Because exceptional precautions were taken to reduce the effect of waterhammer in the Wichita line waterhammer was not the controlling factor for pipe larger than 24 in.; below that size a 20-lb. per sq.in. effect was assumed. A factor of safety of 2½ was applied to all internal pressures and external loads.

Pipe barrel thicknesses were calculated and specified for all of the designated classes in five different

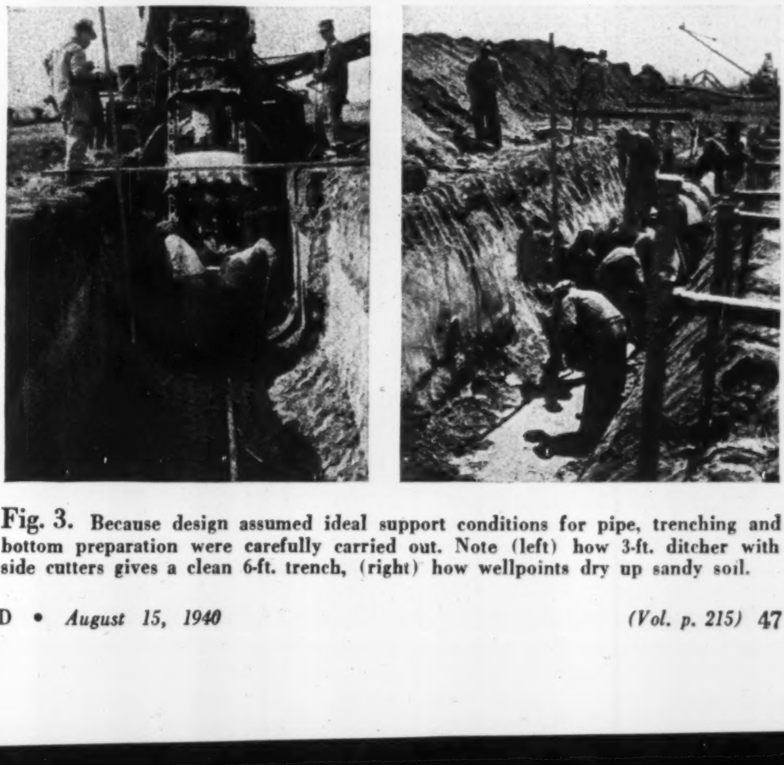

Fig. 3. Because design assumed ideal support conditions for pipe, trenching and bottom preparation were carefully carried out. Note (left) how 3-ft. ditcher with side cutters gives a clean 6-ft. trench, (right) how wellpoints dry up sandy soil.

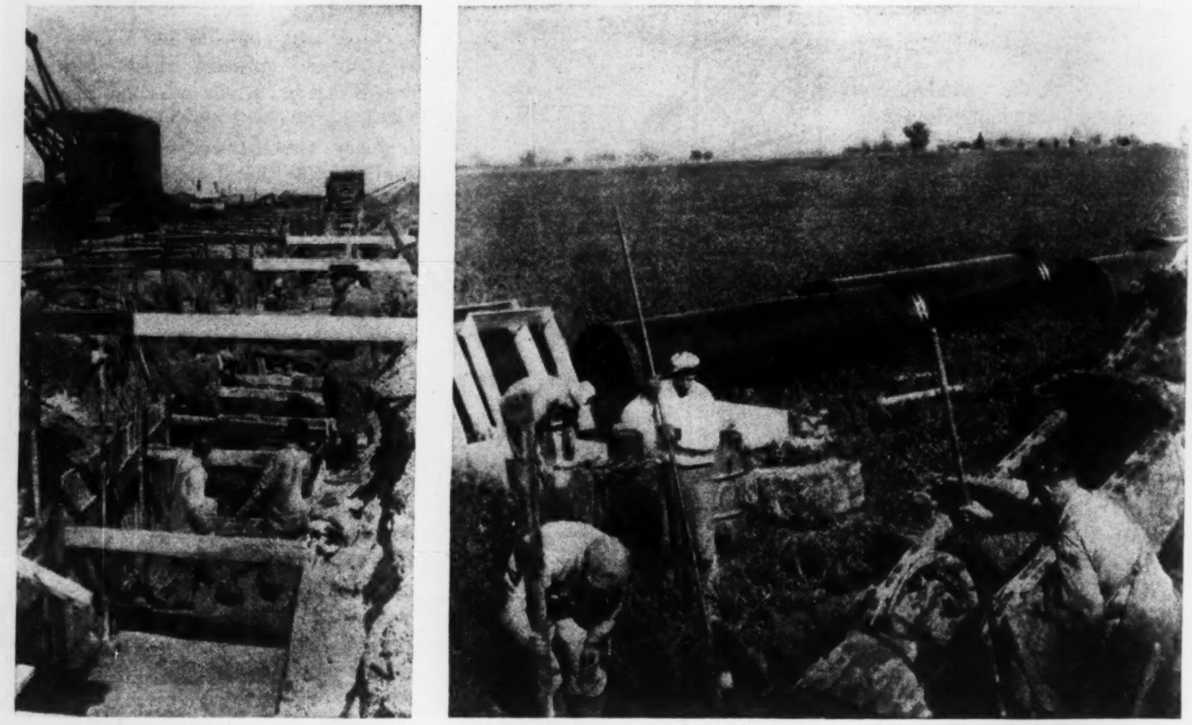

Fig. 4. Wet ground conditions required special practices. In caving, soft ground, wellpoints, vertical sheeting and a concrete trench bottom were used (right). In stable, but wet ground left), timber frames, shown being built, were sunk at pipe joint locations to serve as sumps. Note men with long-handled shovels cutting off lip of trench to prevent caving.

qualities of iron, which permitted manufacturers to select the one of the five which they could best produce; the higher quality iron of course permitted reduction in thickness. The accompanying table gives the specified minimum thickness in inches which includes 0.10 in. foundry tolerance for pipe 24 in. and larger and 0.08 in. for smaller pipe as well as a corrosion allowance of 0.08 in. for all sizes.

Building the pipeline

The construction procedure on this pioneer pipeline involved a number of interesting items, and takes on added importance since assumed design loadings on the pipe depend on trenching and backfilling meeting prescribed standards. Simple as these standards are, they cause appreciable departure from conventional practices. Trench sides had to be vertical up to the top of the pipe. The bottom had to be flat and smooth. Bell holes had to be accurately fashioned. In addition, caulking had to be carefully done and to follow pipe laying closely, and tamping had to be firm and complete up to 6 in. above the springline of the pipe. Since the line traverses wet as well as dry ground, and crosses streams, highways and railways, varied methods were required in preparing the trench to meet the specifications.

Right of way 100 ft. wide across cultivated fields was leased for a full year to eliminate any possibility of suits over damage to crops by construction operations. By this procedure the farmer is paid for his crops, job delays are avoided, and

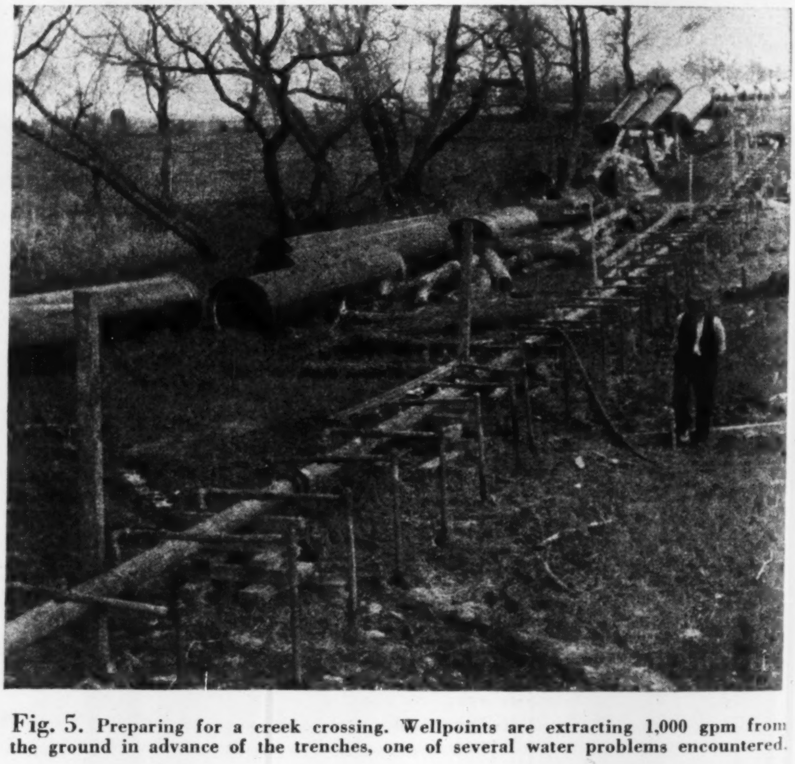

Fig. 5. Preparing for a creek crossing. Wellpoints are extracting 1,000 gpm from the ground in advance of the trenches, one of several water problems encountered.

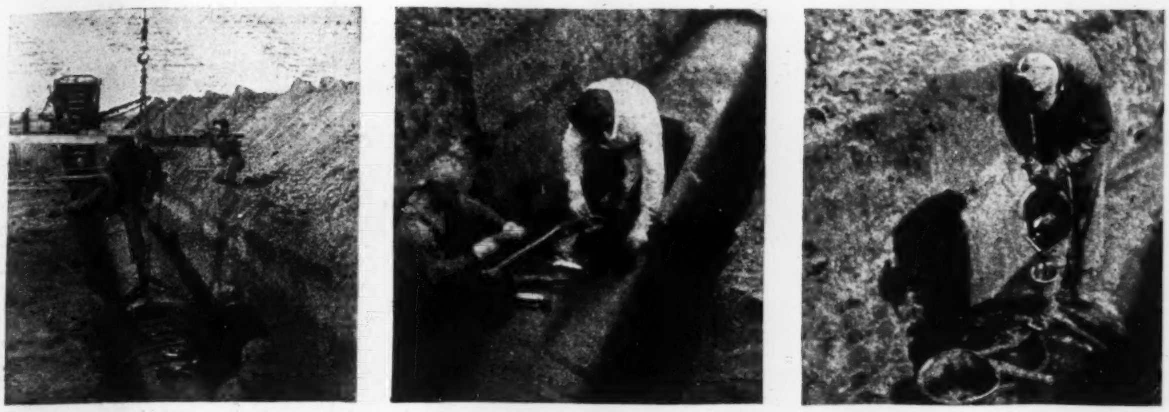

Fig. 6. **Three steps in caulking. As pipe is lowered into trench, braided jute is wound around spigot end. Caulkers then drive it into the bell with caulking tools. Finally a joint runner is placed around the pipe to act as a dam to hold the caulking compound in the bell as it is poured into the metal cone, temporarily cemented at the top.**

the cost to the city is reasonable and even less than would be the case if a number of damage suits had to be settled.

Preparing the trench

Prior to starting work pipe was trucked from rail sidings and strung out along the line. Construction operations then were begun with five crews, each starting at a cone valve location and working upgrade. Usually such wide ditches would be dug with a dragline, but the requirement of vertical sides dictated the use of a trencher, and because the widest standard size trencher is 3 ft. the ladder type machines used were of this dimension and equipped with extension side cutters to produce a trench of the 6-ft. maximum width necessary. Since vertical sides were only required for the height of the pipe, workmen with long-handled spades stood at each side of the ditcher and cut off the lip of the trench on a slope to eliminate any caving tendency. Other workmen in the trench levelled the bottom to specification standards and, when necessary, cut vertical channels in the trenches at pipe bell locations to provide the caulkers with more room.

The above operations sufficed throughout most of the length of the line where the soil was a dry sandy loam. For a number of short stretches, however, water was encountered, and there were several creek beds to be crossed where water handling was a major operation. Special trenching procedures therefore were required.

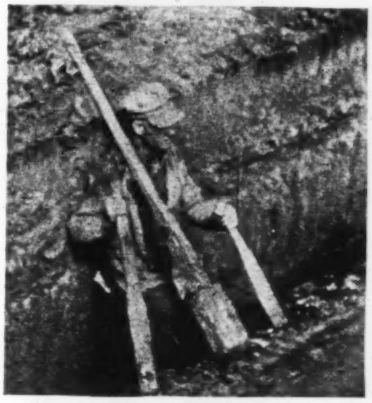

Fig. 7. **Three sizes of tools were used to assure that tamping under and around the pipe would be thorough.**

Where only seepage water was encountered and the trench sides would stand up satisfactorily, the only necessity was to dry up the bottom temporarily until it could be leveled and the pipe laid. At these locations trenching was best accomplished working downgrade, so that the water would drain away from the work. Also the ditch was opened for only one 16-ft. length of pipe at a time, and the bottom was dug 3 in. below grade so that it could be covered with gravel to dry up the water. Any visible seepage holes in the sides of trench were plugged with straw. A timber frame, ditchwide and about 3 ft. long, was then set in at the pipe joint location and excavated and sunk about a foot until its top was slightly above grade level. This served first as a sump to drain the water from the trench, after which it was packed around the outside with straw to keep the water out and then served as a dry cofferdam within which the pipe joints could be caulked.

Where excessive water was encountered, wellpoints at about 5-ft. centers were used to dry up the ground prior to excavation. About 500 ft. of alignment was pumped at a time. Usually this use of wellpoints permitted normal trenching and pipe laying, but if the ground continued to show caving tendencies, resort was had to continuous vertical wood sheeting; and in two instances where quicksand was encountered near creek crossings, the bottom had to be paved with a concrete slab.

Where sheeting was used it was driven 2 ft. below grade and left in place. The bottom concrete slab was 6 in. thick and poured with transit mixed concrete. At bell holes the paving was depressed 6 in. for a length of 1 ft. A 200-ft. length of bottom was placed at one time and allowed to set for 3 days. Then the pipe was laid and cradled in another layer of concrete, followed by tamping and backfilling.

Running water in the creeks crossed was never more than 10 ft. wide. Accordingly, a rough earth dam was thrown up and the water diverted over the job alignment through a temporary culvert pipe.

Laying, caulking and tamping

Pipe was swung into the trench by crawler cranes. Two lines from the crane hook carried a leather-protected chain sling, which encircled the pipe at the spigot end, and a hook which engaged the bell end of the pipe. With this apparatus the large pipe (some of the 48-in. pipe sections weigh 4 tons apiece) was placed with comparative ease. As soon as the spigot end was entered in the pipe already in the trench the sling was removed, and a pull on the line hooked to the bell end drove the heavy pipe length home.

MINIMUM THICKNESSES FOR PIPE OF FIVE QUALITIES OF IRON AND OF VARIOUS DIAMETERS AND CLASSIFICATIONS

		Minimum Thickness in Inches				
Pipe Dia. (In.)	Pipe Class	Quality A (1)	Quality B (2)	Quality C (3)	Quality D (4)	Quality E
30	50	0.64	0.63	0.61	0.60	0.59
30	50–3.5	0.70	0.69	0.66	0.64	0.63
30	50–5.0	0.73	0.72	0.68	0.66	0.65
30	50X	0.80	0.79	0.75	0.73	0.72
36	50	0.71	0.70	0.67	0.65	0.64
36	50–3.5	0.77	0.76	0.73	0.71	0.69
36	50–5.0	0.81	0.80	0.77	0.74	0.73
36	50X	0.91	0.90	0.86	0.83	0.82
42	50	0.76	0.75	0.71	0.69	0.68
42	50–3.5	0.80	0.79	0.75	0.73	0.72
42	50–5.0	0.88	0.87	0.83	0.81	0.79
42	50X	0.99	0.98	0.94	0.92	0.90
48	50	0.82	0.81	0.77	0.75	0.74
48	50–3.5	0.87	0.86	0.82	0.80	0.78
48	50–5.0	0.96	0.95	0.90	0.88	0.86
48	50X	1.09	1.08	1.03	1.01	0.98
48	75	0.85	0.83	0.79	0.76	0.75
48	75–3.5	0.90	0.89	0.84	0.81	0.80
48	75–5.0	0.99	0.98	0.93	0.90	0.88
48	75X	1.12	1.11	1.05	1.02	1.00
48	100	0.89	0.87	0.82	0.80	0.78
48	100–3.5	0.93	0.92	0.86	0.84	0.82
48	100–5.0	1.02	1.01	0.95	0.92	0.90
48	100X	1.14	1.13	1.07	1.04	1.02

(1) 16,000 tensile; 40,000 mod. of rupture; 10,000,000 mod. of elasticity
(2) 18,000 " 40,000 " " " 10,000,000 " " "
(3) 21,000 " 45,000 " " " 11,500,000 " " "
(4) 23,000 " 48,000 " " " 12,100,000 " " "
(5) 25,000 " 50,000 " " " 12,500,000 " " "

As the spigot end of the pipe was about to be entered, the braided jute caulking rope was wound twice around it so that it would be in proper position. With the pipe in place the jute was driven into the bell with caulking tools. The joint runner was then placed in position against the bell of the pipe to hold the hot jointing material—sulphur compound—in place until it cooled and hardened. The caulking compound was poured through a metal cone temporarily cemented to the top of the pipe as shown in Fig. 6. After the annular space around the pipe was filled, the cone was filled to the top, this head of liquid assuring that the joint would stay full until it hardened. The final operation was to remove the joint runner and to knock off the pouring cone.

Simultaneous with the caulking other workmen tamped backfill under and around the pipe. Great care was exercised in this work, and three sizes of wood hand tampers were used—one with a very short handle for work under the pipe, another with a slightly longer handle for the outer edges of the pipe bottom, and a long handled tamper with a block on the end for final vertical tamping. Hand filling and tamping continued up to 6 in. above the springline or the mid-diameter of the pipe, after which the trench filling was completed by a drag operated by a crawler crane.

Average advance on the large pipe was between 400 and 500 ft. of completed line per 8-hr. day, with 800 ft. on good days and 1,000 ft. on the best day. As much as 1,500 ft. of 24-in. line was completed in one day; result of a well organized working plan.

Personnel

The project is being constructed at a total cost of $2,425,000, of which $1,091,250 is made available through a PWA grant. The work is under the supervision of Alfred McDonald, city manager, P. L. Brockway, city engineer, and M. E. Rogers, coordinator, for the City of Wichita. Black & Veatch, consulting engineers of Kansas City, Mo., are the designing and supervising engineers for whom R. E. Lawrence is principal engineer in charge of the project, A. V. Ferry, project engineer on construction, and T. D. Samuels, III, resident engineer on the filter plant. W. B. Carter, Wichita, is the pipeline contractor and Carrothers & Crouch, Kansas City, is building the filter plant.

Average Motorist Pays Toll 8 Times Yearly

Tolls are collected at bridges, ferries and tunnels on 635,000 vehicles daily according to an estimate of the Public Roads Administration of the Federal Works Agency. The number of tolls paid each day is slightly more than 2 per cent of the number of registered vehicles. The average motorist thus pays a toll about eight times a year. These estimates are based on data for 1938 reported by the 46 states engaged in conducting highway planning surveys in cooperation with the PRA.

Daily bridge tolls are collected from 477,000 vehicles, ferry tolls from 100,000 vehicles and tunnel tolls from 58,000 vehicles.

There are 660 ferries operating between fixed terminals, of which 60 are publicly operated. Twenty-six toll ferries are international, 178 are interstate, and 456 are intrastate.

There are 241 toll bridges and five toll tunnels serving highway traffic. Ninety-eight bridges and three tunnels are publicly owned and 142 bridges and two tunnels are privately owned. One bridge is classified as of quasi-public ownership. Two tunnels and 126 bridges are intrastate in character, two tunnels and 94 bridges are interstate, and one tunnel and twenty-one bridges are international, connecting with Canada or Mexico.

New Staggered-Floor Garage Design Cuts Cost

V. Lankovsky

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Department of Water and Power, Los Angeles, Calif.

***Contents in Brief**—A 400-car ramp garage at Los Angeles was designed to (a) permit speeds up to 30 mph in handling cars, (b) increase storage space as compared to conventional design provisions, (c) do away almost entirely with forced-draft ventilation and (d) decrease total cost 20 per cent. Floors are "staggered" (at different levels in opposite halves of the building) permitting short, straight ramps and the use of overlapping areas for storage.*

A GARAGE recently built in Los Angeles for the Bureau of Power and Light was designed to afford a considerable saving in total cost, increase efficiency of operation, effect a 60 per cent decrease in average length of travel to storage point, reduce reverberation and simplify the usual ventilation problem.

By the use of staggered, overlapping floors connected by short, straight ramps near the center of the building, car storage capacity is increased approximately 20 per cent, and a corresponding reduction in building cubage. The adoption of this plan resulted in a saving of $62,000 based on a unit cost of $2.70 per sq. ft. of floor area.

This estimate of saving is based on comparative studies of different types of buildings, all designed for the same requirements, namely storage for 400 cars plus 9,000 sq. ft. of floor area, including warehouse, office, repair shops, stair and elevator space. Among these studies was a comparison of the conventional garage layout with the staggered, overlapping floor system, where both have the same lot area and type of construction: the latter design shows a decrease in required total floor area from 126,480 to 103,530 sq. ft., resulting in a decrease per car unit from 303 sq. ft. to 227 sq. ft., a decrease in average length of travel from 1,500 to 500 ft., a reduction in building height from 84½ to 70 ft., and a marked decrease in sound reverberation due to smaller area at each floor level, plus large ramp openings.

The ramp design used was adopted after long study, including experiments with building models and toy automobiles, to determine the proper banking of ramps, and the necessary warping in floor slabs at top and bottom of ramps, to increase safe speeds, to eliminate "bumps" and to minimize tire friction. Ramps are located in the center, or overlap section of the structure to make possible a continuous, spiral movement of cars through the building. Proper curvature of the ramp surfaces assures smoothness of travel and permits speeds of 30 mph with safety. Typical ramps are 19 ft. 5 in. wide and 34 ft. long with a grade of about 20 per cent. These dimensions permit the largest truck owned by the bureau to travel to the roof. Scored surfaces on the ramps improve traction and permit greater speed. Each ramp has a drain at the bottom.

A ceiling height sufficient to permit the overlapping storage, plus the large centrally located ramp openings, combined with a multiplicity of large pivoted sash windows, practically eliminates the necessity for forced-draft ventilation. There are a number of scuppers or air drains on each floor level, as required by the city's building code, to collect air that is charged with carbon monoxide and these lead into ducts from which two 5-hp fans exhaust at roof level. These fans constitute the only ventilation required.

The building plan is rather irregular, roughly 112x170 ft. with nine staggered and overlapping floor and roof levels. Total height approximates that of a five-story building. The design is class "A" construction, conforming to the city's building code provisions for public garages, and has a framework of fireproofed, structural steel, reinforced concrete floors, roof slabs and ramps, and reinforced concrete outer walls. As the outer walls are pierced by many window openings, massive reinforced

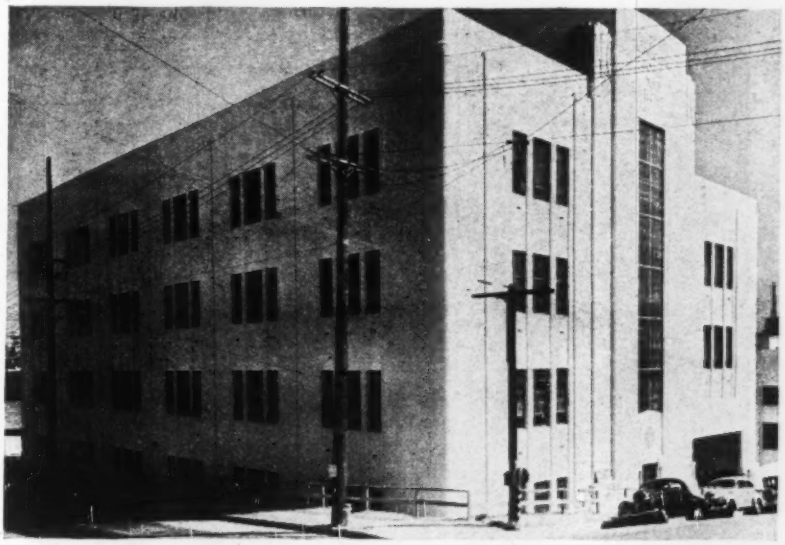

Fig. 1. **Building is of fireproof construction; steel frame, reinforced-concrete floors, roof slabs, ramps and outer walls. On account of fenestration, massive reinforced concrete piers are used, poured monolithically with walls and spandrel beams.**

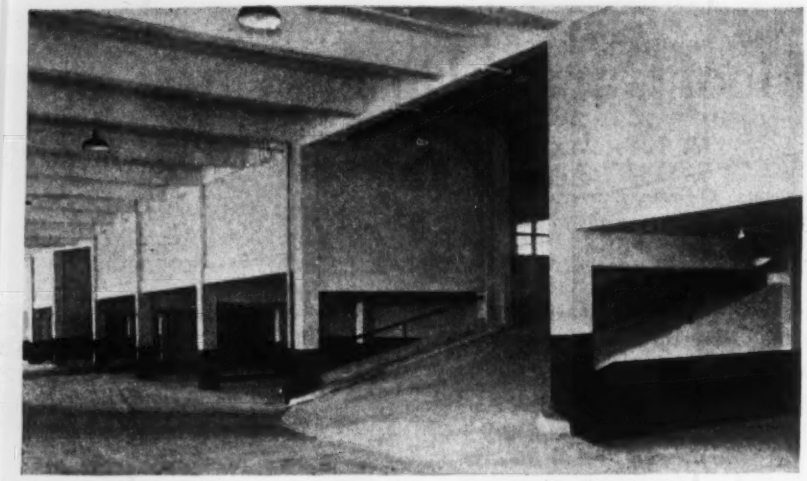

Fig. 2. **Floor levels at half-story height on opposite halves of building make short straight ramps and permit use of over-lapping floor areas for increased storage.**

concrete piers are used, poured monolithically with walls and spandrel beams. Spread footings are provided for interior columns and continuous footings extend under outer walls, all with ample reinforcing. The underlying soil strata is "Puente" shale, in which no piles were required.

The low height of the building, its massive exterior and unyielding monolithic floor diaphragms, plus a design to withstand a lateral force of 0.1g, make the structure highly resistive to seismic disturbances. The Los Angeles building code requirement that the structural frame design include provision for lateral loads of 0.02g was waived by the city's building department, because of the additional 0.02g lateral load provided for in the walls. It was agreed that this substitution compensates for and even exceeds any increase in lateral forces produced by the rotational shears in the building.

Floor heights were established at 17 ft. 4 in. so that the overlap sections would have a clearance of 8 ft. required for the large equipment operated by the bureau. There are no beams in the overlap sections except girders between columns. The heavy 8-in. concrete slabs are adequately reinforced for shears and moments produced by maximum live and dead loads.

All interior partitions are reinforced concrete, metal lath and plaster, hollow metal or a fireproofed wood fibre on metal supports, faced with plaster. All interior doors and exterior office doors are hollow metal, and all exterior openings for automotive equipment are supplied with motor-operated rolling steel doors. The building has a complete sprinkler system; at ramp openings on levels 3, 5, 7 and 9 are steel rolling doors equipped with fusible links, completely isolating, in case of fire, large sections of the garage. There is a standard fire escape on the east wall and on the west wall an enclosed stairway from first level to the roof.

The entrance to the garage is 26 ft. 4 in. wide, providing easy access and egress. The dispatcher's office is along the south wall, close to the entrance and outside the line of travel.

Responsible for the various phases of the building design were the following engineers of the bureau's design and construction division: V. Lankovsky and J. de Forrest Griffin, structural and architectural; J. P. Stratford, electrical, and C. D. Udell, mechanical and plumbing. F. L. Roehrig was consulting architect. All design was under supervision of C. P. Garman, assistant engineer of design reporting to H. C. Gardett, engineer, design and construction division and assistant chief electrical engineer and general manager. E. F. Scattergood is the chief electrical engineer and general manager of the Bureau of Power and Light, Los Angeles Department of Water and Power.

As certain features of the design are patented, license was obtained from M. D. East, the inventor. The contract was awarded, on competitive bidding, to the Ford J. Twaits Co., Los Angeles.

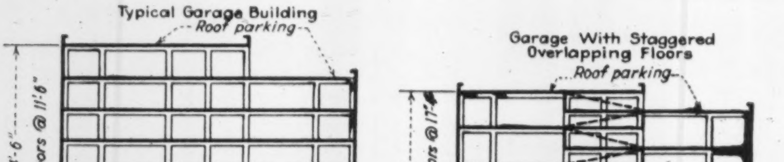
Typical Garage Building
Roof parking
84'-6"
6 floors @ 11'-6"
15'-6"
390 Cars
Garage With Staggered Overlapping Floors
Roof parking
79'
3 floors @ 17'-4"
11'-8"
15'-4"
421 Cars
Typical Elevations
112'
Line of travel
70' long
16' ramp
25' driveway
25' driveway
180'
166'
Stair and elev.
Designates cars
112'
Line of travel
21' ramp, 34' long
27' driveway
27' driveway
180'
166'
Stair and elev.
Typical Floor Plans Above Third Floor Level

Fig. 3. **Comparison of plan and elevation for conventional garage design with the staggered and overlapping floor system; same lot area and type of construction.**

Refuse and Sewage Plant Combined for Profit

GEORGE O. CONSOER and DARWIN W. TOWNSEND

Consoer, Townsend & Quinlan
Consulting Engineers, Chicago

***Contents in Brief**—Municipal wastes of all kinds in Rock Island, Ill., will be disposed of at a plant treating domestic sewage, grinding garbage and burning sludge and trash. Byproduct gas from the digesters will serve as fuel for all pumping and plant operation needs. Rehabilitation of inadequate sewerage will provide flood relief.*

A MODERNIZED sewerage system, with new stormwater and intercepting sewers, and pumping equipment and a dual sewage and garbage treatment plant, with incinerators for both municipal refuse and sewage sludge, are included in a project now approaching completion at Rock Island, Ill. The estimated cost of $2,900,000 is being met with a PWA grant of 45 per cent, supplemented with funds raised by sewer revenue bonds.

The plant arrangement is such that the entire service for refuse and waste disposal will be operated from a central location and under one management. Besides the improvement in sewers and disposal of sewage and wastes, this comprehensive project will eliminate periodical flooding in a large part of the city, due to inadequate stormwater drainage and backwater from the Mississippi and Rock rivers. The new works are designed to serve 50,000 in 1960; the present population is 40,000.

Protection against overflow flooding of a low-lying business and industrial section is afforded by the embankment of the Chicago, Rock Island & Pacific Ry., which practically parallels the Mississippi and has its top at El. 561, or one foot above the highest flood record. But numerous sewer outlets admit water at high stages of the river, while stormwater at such stages backs up in the sewers.

In the piecemeal development of the existing sewer system, which consists mainly of combined sewers, little attention had been given to any general plan or to sewage treatment, and many of the combined sewers are quite inadequate for stormwater runoff. Raw sewage has been discharged into watercourses through a number of outlets. As a result of neglect to consider the effect of high river stages on the discharge of combined sewers in time of storm, flooding of streets and basements has been a frequent occurrence.

With the advent of PWA, the city authorities became actively interested in the construction of a sewage treatment plant, but insisted that for financing on a sewer revenue plan the project must include stormwater relief sewers and garbage disposal. It was said that unless these features were included, the people would not approve a large expenditure. A PWA grant of $1,350,000 was secured in 1938.

Studies of the behavior of existing combined sewers in high and

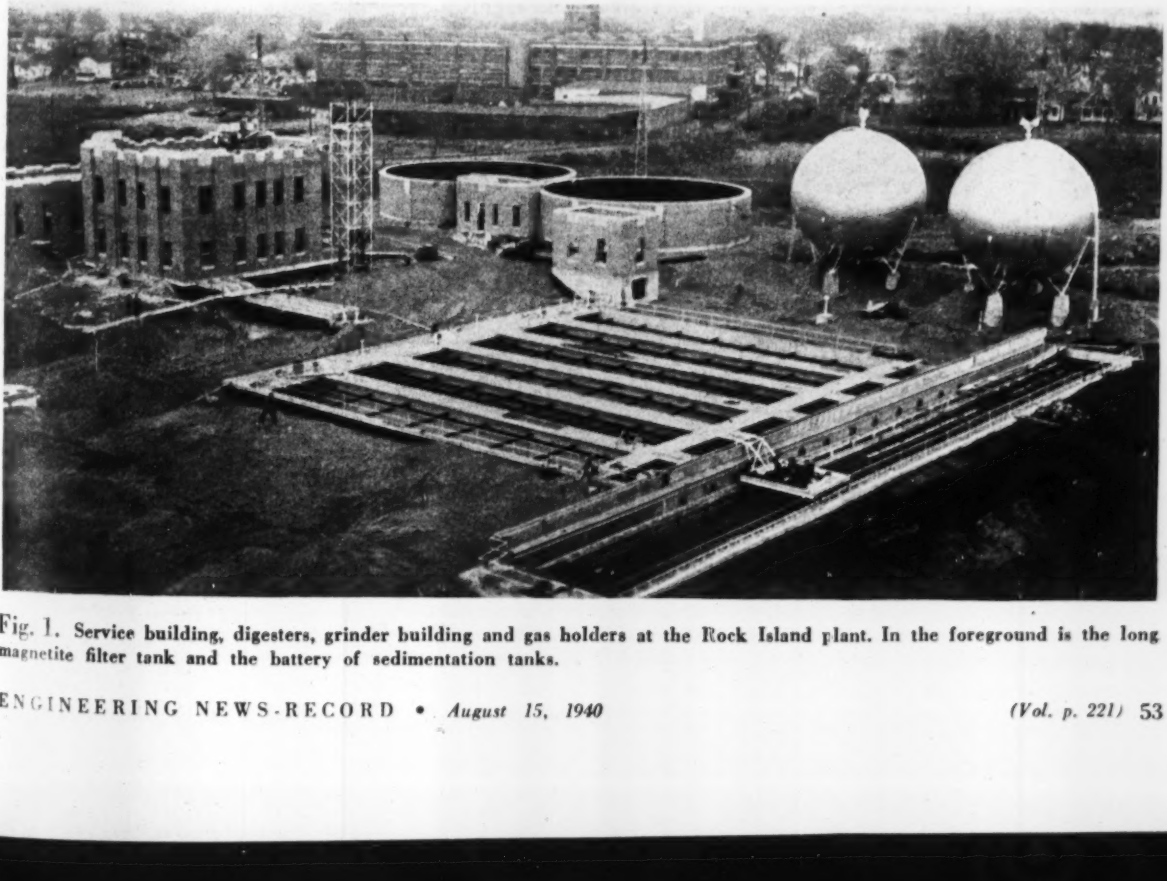

Fig. 1. **Service building, digesters, grinder building and gas holders at the Rock Island plant. In the foreground is the long magnetite filter tank and the battery of sedimentation tanks.**

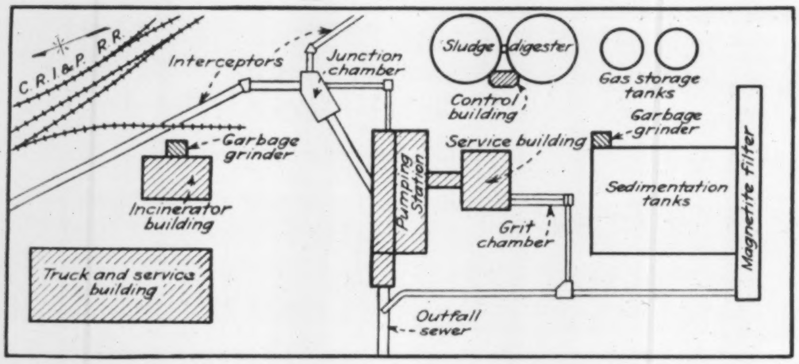

Fig. 2. Combined plant for sewage and garbage disposal and stormwater pumping.

hilly areas indicated that these sewers have sufficient capacity for the heaviest storms when designed to carry runoff at a rate of 1 cfs per acre (corresponding to a runoff factor of 50 per cent with a rainfall of 2 in. per hour). This figure was used therefore in the design of all relief sewers and gravity intercepting sewers for the steeper hill sections. In the flat low-level areas, with slower runoff, the figure was taken at 0.48 cfs per acre, or a runoff factor of 25 per cent.

Stormwater sewers in parts of this area serve also as intercepting sewers. These are graded to give adequate velocity for minimum dry weather flows. To provide for the elimination of local floods, a departure was thus made from the usual practice of designing the interceptors to carry only a small multiple of the future dry weather flow. About 1,100 acres of the city are at such low elevation as to require pumping of stormwater during high water stages of the Mississippi, the maximum storm discharge being assumed as 400 cfs. A 9-ft. main outfall sewer from the pumping station to the river is designed to carry this storm discharge.

Two major gravity relief sewers were planned on the basis of studies of the present sewers:

(1) A 36-in. line just outside the boundary of the pumping area, with outlet to Sylvan Slough (an arm of the Mississippi);

(2) A 72-in. line from 13th Ave. and 20th St. to the Mississippi at the foot of 16th Ave. The latter has gravity flow to the edge of the low-level area, beyond which the flow is under pressure when the river is at high stage. These sewers were designed for the dual purpose of relieving the existing sewers and eliminating unnecessary pumping of water from areas able to discharge by gravity.

Discharging into the upper ends of the combined stormwater and intercepting sewers are other intercepting sewers which collect only dry-weather flow at points where existing combined sewers had outlets to the river. Intercepting devices are of the hydraulically unbalanced leaf-gate type, in concrete structures. Backwater swing gates are provided to prevent river water, at high stages, from flowing into the intercepting sewers. Areas draining to the Mississippi are served by a 36-in. interceptor; those draining to the Rock River have a 30-in. line paralleling the river.

Sewage gas for pumping

Pumping equipment for the 400-cfs stormwater discharge from the 1,100-acre low-level area is to be in the same building with the pumps for the treatment plant. Five sewage gas-engine pumps and two electric (standby) pumps are to be installed for the intermittent stormwater service; two gas-engine pumps of 3-mgd and 5-mgd capacity and two electric pumps of similar capacity will provide for the continuous pumping to the plant. The stormwater pumps are all 30-in. centrifugal units of the mixed-flow type, with closed impellers and a total capacity of 210 mgd. Speed-reduction gears are used for the gas-engine pumps, but the others are direct-connected to the motors.

Pump suctions are placed in widened sections of the interceptor, and the discharge is into the 9-ft. outfall sewer built above the interceptor. For this reason the eleven pumps are placed in line. The connection of the outfall sewer with the interceptor is provided with swinging backwater gates and electrically operated sluice gates, so that flood discharge may be by gravity during low water and pumped only during high stages of the river.

Since the pumping station and treatment plant are located in the low-level area, flooding is prevented by having the tops of tanks and other structures above the highest flood record. This necessitates the pumping of dry-weather flow at all times.

Garbage aids gas output

Special attention has been given to the production, use and storage of sludge gas. Ground garbage will be added to the sewage sludge, both as a means of disposal and to in-

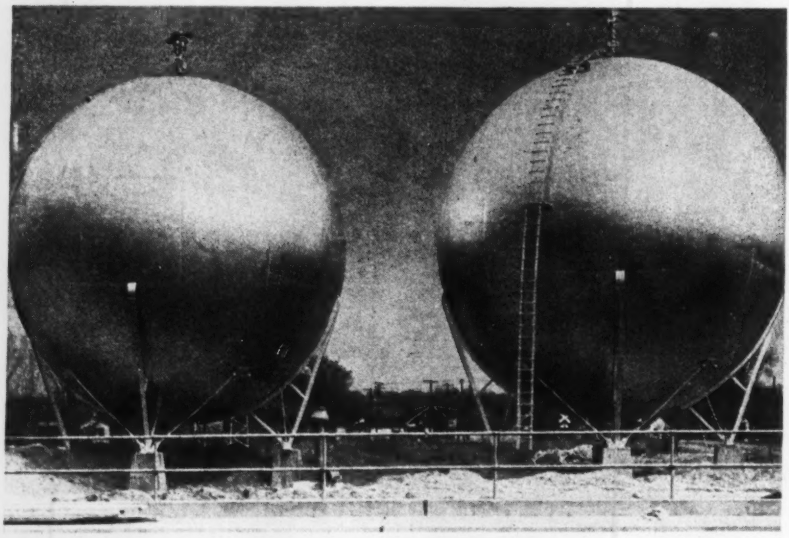

Fig. 3. Sludge gas stored in these tanks will operate the Rock Island plant.

crease the output of gas for fuel use. Until the plant is in full operation and has sufficient gas in reserve, a supply from the local gas company will be used.

Sludge digestion is estimated to produce gas of 650 Btu at the rate of 1 cu.ft. per capita, or at a higher rate with the addition of ground garbage. Gas will be used ordinarily for all pumping, with electric power for standby.

Because of a large peak demand for gas for pumping during storms, two gas-holders of 50,000-cu.ft. capacity and 50-lb. pressure are provided to insure reserve supply. A small gas-engine generating unit will furnish current for lighting and for miscellaneous machines. Gas or fuel oil will serve the incinerators. Buildings and sludge digesters will be heated either from heat-exchangers on the exhaust line of the engines or by gas-fired heaters. It is expected that the plant will be self-sufficient for heat and power requirements.

For garbage disposal, two grinders are provided: One, at the incinerator building, Fig. 2, is for grinding garbage that may be added to the sewage as it enters the plant, or to be burned in the sludge furnace. The other, at the sedimentation tanks, is for ground garbage to be added to the settled sludge and pumped with it to the digesters. The use of these alternative methods was the result of conferences with the State Department of Public Health.

Garbage dumped from trucks on the unloading floors will be charged by hand to the hoppers of two motor-driven grinders of the swing-hammer type, each rated at four tons of green garbage per hour in reducing the material to pass a ½-in. screen. This product falls by gravity into the influent sewer or alternately into a concrete well which also receives raw sewage solids from the settling tanks. In this well a vertical shaft agitator of the propeller type mixes the sludge and garbage which is then pumped to the digesters.

Filtered sludge and ground garbage from a population of 50,000 may approximate 18 tons daily, and is estimated to contain 10,000 Btu per pound. To provide for peak rates and to adjust the burning periods to working hours, the incinerator will have a capacity of 24 tons per day, using a furnace of the multiple-hearth type.

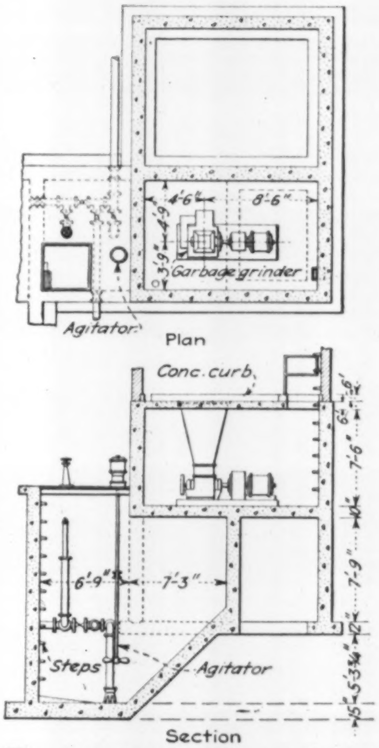

Fig. 4. Garbage grinding building and mixing tank details.

Mixed municipal refuse will approximate 30 tons per day, and for this a trash incinerator of 40 tons daily capacity is provided. Both furnaces will use sludge gas or fuel oil. Adjacent to the incinerator building is a garage for 35 garbage collection motor trucks, with washing rack and repair facilities.

Sewage treatment facilities

Sewage treatment consists of primary sedimentation followed by magnetite-sand filtration for the effluent from the settling tanks. When operated on an average sewage flow of 7 mgd it will remove from the raw sewage an average of 65 to 70 per cent of the suspended solids and 40 to 45 per cent of B.O.D. The city's sewage is of moderate strength, and the B.O.D. (based on the present population of 40,000) amounts to 0.21 lb. per capita. The water consumption closely approximates the sewage flow of 125 gal. per capita per day, and the plant is designed to handle 140 gal., assuming a population of 50,000 by 1960.

Duplicate grit chambers 60 by 3 ft., with a maximum flow depth of 5.5 ft., have a straight-line collector for each compartment and a grit washer serving them both. Sewage enters through a 24-in. pipe from the pumps. Aluminum stop plates in vertical grooves at the outlets provide for regulating flow, depth and velocity, and also for excluding backwater. To exclude odor from the service building, partition walls enclose the flow-control end of the grit chamber and the washing mechanism.

Two sludge digesters, of reinforced concrete, are 60 ft. in diameter, with depth of 27 ft. at the wall and 32 ft. at the center. They extend 14 ft. above the ground, and the exposed part is masked by brickwork for architectural effect. A 4-in. space between the concrete and brick prevents heat loss from the tanks. The digester capacity is 3 cu. ft. per capita for 50,000 population. Covers of the floating type are to be used.

Steel frames on the concrete walls of the digesters carry heater coils of 3-in. wrought-iron pipe, through which water at 120 deg. F. will be forced in a closed circulation system. The liquid contents of the tanks will be kept at 85 deg. F. In the adjacent digester control structure are housed the gas meters and other control apparatus, as well as a motor-operated compressor for compressing gas in the storage tanks at 50 lb. pressure.

Filters in service building

A three-story service building houses in its basement the sludge pumps and other pumps, service boilers, blowers, generator set for the magnetite filter and venturi meter for the raw sewage. On the first floor are the workshop, locker and toilet rooms, loading room for grit and sludge trucks, and the grit washer.

The upper floor has two vacuum sludge filters, chemical laboratory, offices and chemical feeding and sludge mixing facilities. Each sludge filter, 4 ft. in diameter and 6 ft. long, will deliver a cake of 75 per cent moisture content when filtering sludge at the rate of 2½ dry pounds per square foot of filter surface per hour.

The sludge will be chemically conditioned before filtration in order that the product will be satisfactory for burning. Sludge from the filters is discharged into a bottom-dump hopper which loads the trucks in the room below. Wet filtered sludge will approximate 10 tons daily, with 6 tons of digested garbage in addition.

There are three settling tanks 102 by 33 ft., with an average depth of 8.25 ft., proportioned for a detention period of $1\frac{1}{2}$ hours when receiving an average flow of 7 mgd. The maximum flow design is for 10 mgd and the present rate about 5 mgd. Each tank has tandem straight-line sludge collectors, cross collector, submerged baffled inlets and multiple-outlet weir channels.

The sand filter is 174 by 13 ft., operating at rates of 1, 2 or 3 gal. per sq. ft. per minute for minimum, average and maximum sewage flow, respectively. It has a 3-in. layer of magnetite sand of such size that 95 per cent will be retained on a No. 20 sieve, and 100 per cent will pass through a No. 10.

Direction

Consoer, Townsend & Quinlan, of Chicago, Ill., are the consulting engineers, with Eugene Hardin in charge of treatment plant design, George Consoer in charge of sewer design, and George W. Brunkhorst and Richard Cook as construction engineers.

The project has been under the supervision of the Chicago office of PWA, with D. R. Kennicott, regional director; J. P. Elston in charge of checking designs, and John T. Ward, Jr., in charge of field supervision. Preliminary engineering work was under the direction of William Gallagher, city engineer of Rock Island.

Construction of the sewers was divided among several contractors. E. M. Rocho, Freeport, Ill.; Drainage Construction Co., Detroit, Mich.; McCarthy Improvement Co., Davenport, Iowa; Keeler & Phelan, Davenport, Iowa; Gjellefald Construction Co., Forest City, Iowa, and Dan Christiansen Construction Co., Cedar Rapids, Iowa. The reinforced concrete sewer pipe was made locally by the Lock Joint Pipe Co. of Ampere, N. J.

The sewage treatment plant is being built by the Stark Building Co., Cedar Rapids, Iowa. The project is scheduled for completion this summer.

Roads That Cut Car Costs

***Contents in Brief**—A record of rural mail travel totaling over 3,000,000 car miles on three types of road surfaces, clean, snow-covered and muddy, shows reduction of car costs with improvement in surface. Detailed figures indicate economy of substantial expenditures for all-weather surfaces and snow removal.*

IN A NOTABLE STUDY of car costs as influenced by the character and condition of the highways traveled (paved and unpaved), rural mail-carrier traffic was selected as significant of traffic operation on rural highways throughout the year and regardless of weather conditions. An extended account and analysis of this investigation are given by R. A. Moyer and Robley Winfrey in Bulletin No. 143 of the engineering experiment station of Iowa State College, from which the following information is condensed.

While the operation of a motor car in rural mail service is not typical of all cars on rural highways, it has much in common with school-bus service, transportation of farm products and farm delivery of fuel and supplies. The mail cars also constitute a good proportion of the traffic on these roads. Stops are frequent and speeds rarely exceed 30 to 40 mph. For these reasons, a study of the operating costs of cars operated by rural mail carriers is considered fairly representative of car operation on the purely local and farm-to-market roads which comprise about 2,000,000 miles of the 3,000,000-mile highway system of the United States.

Cars and operating conditions

The study, made with the cooperation of the National Rural Letter Carriers Association, covered 293 cars on 170 routes (140 routes in Iowa), and operating on roads classed as follows: (1) rigid and semi-rigid paving; mainly concrete but also asphalt, brick and oil-treated gravel; (2) untreated roads surfaced with gravel, crushed stone, sand-clay or cinders; (3) untreated natural earth (clay, loam, gumbo or sandy soil). The total travel of 3,104,247 miles during the year was divided almost equally over the three classes of roads, and also over the four quarters of the year, the seasonal influence being small as to the traffic, though large as to cost of operation. The number of mailboxes averaged 4 per mile on the paved and gravelled roads, and $3\frac{1}{4}$ per mile on earth roads.

In weight, the cars averaged 3,150 lb. empty, and carried an average mail load of 135 lb., this load ranging from 50 to 375 lb. The number of passengers averaged $2\frac{1}{2}$ per car. While light, low-price cars were commonly used, there were several heavy cars, and their age averaged $2\frac{3}{4}$ years, with a maximum of $10\frac{1}{2}$ years. Maintenance expenses tended to rise as the mileage increased to about 50,000 miles. Tires averaged a life of 24,000 miles on paved surfaces, 14,000 miles on gravel and 19,000 miles on earth roads.

Rural highway conditions

The cars included in this investigation are operated largely on concrete, untreated gravel and untreated earth, with very marked differences in operating costs. It is pointed out that motor car owners in general do not realize the price they pay to operate on unimproved roads, and their protests are made mainly because such roads are often impassable or in such condition as seriously to reduce the speed of travel. An expedient used frequently to reduce troubles due to mud is to place gravel, sand or crushed stone on the surface. But loose granular material of this kind may increase the operating-cost items of fuel, tires and car maintenance. Such materials may also create dust and accident hazards more serious than on an earth surface. Many Iowa county trunk roads have been surfaced with gravel for considerably less than $1,000 per mile, and the annual reports of the Iowa State Highway Commission indicate that a fair average maintenance cost for county trunk roads is $160 per mile for earth roads and $200 per mile for graveled roads.

The report states that a significant point is the saving in time made possible when traveling on paved or graveled surfaces, in comparison with that on earth surfaces. It is estimated that reducing the time on the route by 25 to 50 per cent has a real money value, which in itself may justify the construction of all-weather roads.

Differences in unit operating costs of cars which are attributable to variations in road surface or condition may easily amount to 2c. per mile, and this figure may be doubled or trebled if the value of time is taken into account. The cost of gasoline and tires is higher on gravel than on earth, probably due to the loose and corrugated condition of untreated gravel roads in dry weather, when earth roads are smooth, though probably dusty. Three important factors in car-operating costs are the road surface, road maintenance and snow or mud conditions. Some of the figures given in the bulletin are assembled in Table I.

Taking a typical car, the average cost of operation for 15,000 miles of travel on the three classes of road are summarized in Table II.

TABLE I — OPERATION COSTS OF RURAL MAIL CARS ON THREE CLASSES OF RURAL ROAD SURFACES

	Paved roads	Gravel roads	Earth roads
Gasoline, oil, tires and car maintenance; c. per vehicle-mile	1.56	2.59	3.14
Miles per gallon of gasoline	15.02	13.04	13.52
Miles per quart of oil	264	159	113
Gasoline c. per mile; winter	1.50	1.54	1.58
Gasoline c. per mile; summer	1.21	1.24	1.13
Car maintenance, c. per mile:			
Winter	0.28	0.77	1.70
Summer	0.05	0.38	0.63
Annual cost of operation:			
15,000 mile	$500.26	627.76	680.26
c. per mile	3.35	4.19	4.54

	Paved and Gravel roads	
Operating cost for car, c. per miie:		
Average	3.8	7.8
Maximum	6.0	12.0
Minimum	2.0	5.0
Extra help on bad roads; c. per mile:		
Average	0.2	1.0
Winter	0.8	2.4
Average annual travel; miles	20,000	4,000
Speed, including stops; mph; Average	13.0	8.8
Speed, including stops; mph; summer	14.5	10.5
Speed, including stops; mph; winter	11.5	7.5

TABLE II — OPERATING COST OF TYPICAL RURAL MAIL CAR ON THREE CLASSES OF ROAD SURFACES

	Cents per vehicle mile Paved roads	Gravel roads	Earth roads
Gasoline	1.22	1.40	1.35
Oil	0.11	0.15	0.21
Tires	0.27	0.44	0.33
Maintenance	0.10	0.56	1.01
Total	1.70	2.55	2.90
License, etc.*	1.64	1.64	1.64
Grand total	3.34	4.19	4.54

* This item covers license depreciation, interest at 6 per cent, garage and insurance.

Seasonal influences

The greatest difference in operating cost is between winter and summer. On paved roads, the cost per vehicle mile was 1.89c. and 1.36c. for winter and summer respectively. On graveled roads, 2.47 and 1.77c., and on earth roads, 3.50 and 1.96c. Thus there is a seasonal difference of 0.53c., 0.70c., and 1.54c. per vehicle mile for the three classes of road. This is taken to indicate the need for snow and ice removal and also the elimination of mud, especially on earth roads. Now that winter driving is common, snow removal has become a major service for state highway departments, and the cost of operation on snow bears a close relation to that on an earth road, since a car may be stalled in soft snow as easily as in deep mud on an earth road. Bucking snow and driving in soft snow consumes additional gasoline and requires extra time for the journey.

Extra help required when the roads were in bad condition was of two kinds: (1) that required when roads were passable but the carrier needed assistance on account of slow and difficult travel; (2) when the roads were impassable on account of snow or mud, so that a horse, team and wagon or men on foot had to be called on to supplement the car service. The cost of replacing cars with men on foot or horseback averaged 11c. per mile, as compared with less than 5c. with the car when the roads were passable. On paved and graveled roads, the use of extra help was due to snow and blizzards, but on earth roads it was due also to mud, which interfered seriously with traffic.

Based on the results of this extended investigation of conditions and car operating costs, the conclusions presented may be summarized as follows: (1) The total average annual cost of operating the rural mail-delivery cars, based on an annual travel of 15,000 miles, was $500.26 on pavement, $627.76 on gravel, and $680.26 on earth, or 3.34c., 4.19c., and 4.54c. per mile respectively. (2) A traffic volume of 63 vehicles per day will justify an annual interest charge of 4 per cent on an investment of $1,000 per mile and an increased road maintenance expenditure of $40 per mile per year for improving a country trunk earth road with a gravel surface, based on the difference of 0.35c. per mile in car operating cost. If an additional charge is made to amortize this investment over a period of ten years, a daily traffic volume of 128 cars will justify the change. (3) A traffic volume of 25 vehicles per day will justify the improvement from earth to gravel if travel time is evaluated, as in this study, and if the amortization of the investment is included. (4) An expenditure of 0.5c. per vehicle mile is justified for snow and ice removal from paved surfaces during the three winter months when only the difference in operating cost is considered, and 1.22c. when the time factor valued at 40c. per hour is included.

Two billion dollar saving

In addition, the following may be noted: (5) a considerable increase in expenditures for secondary roads is justified to eliminate mud roads and loose, dusty, washboarded gravel and macadam roads, on which operating costs are from 1 to 8c. higher than on pavement. (6) Highway departments in the northern states are justified in an annual expenditure for snow and ice removal at the rate of $500 per mile of road per 1,000 vehicles per day, in view of savings in operating cost and time, and in the reduction of accidents due to such removal. (7) With unit operating costs that range from 2 to 12c. per mile for passenger cars, an average saving of 1c. per vehicle mile would result in a total annual saving of $50,000,000 in Iowa and two billion dollars for the country as a whole. This investigation is thought to indicate that such an achievement would be possible.

Repairing a Concrete Arch Viaduct

RALPH VAN BRIMMER

Bridge Deputy, Summit County, Akron, Ohio

***Contents in Brief**—Poor drainage at roadway expansion joints and 20 years' general maintenance neglect caused extensive deterioration in Akron's North Hill Viaduct. Repair consists of cutting out of all bad concrete, cleaning or replacing steel and building back the section with pressure concrete. Under deck work carried out from traveling and swinging scaffolds. Traffic maintained by closing only a 600-ft. length of half the bridge width at a time.*

AN INTERESTING concrete repair job is now in progress on the open spandrel arch bridge in Akron, Ohio, known as the North Hill Viaduct. This structure, 2,840 ft. long and consisting of sixteen arches and two beam and girder approach spans, passes over the Baltimore & Ohio Railroad, the Little Cuyahoga River, six city streets and a residential district. At its highest point, the 5-lane roadway is 130 ft. above the river. It carries state highway routes as well as heavy local traffic from downtown Akron to residential North Hill and Cuyahoga Falls. In addition to the 52-ft. roadway, which in the case of the arches is carried on longitudinal beams supported on crossbeams spanning between the two arch ribs, there are two 10-ft. cantilevered sidewalks.

The bridge was constructed by Summit County in 1918-1922, and has suffered considerable damage through leaking expansion joints, the infiltration of surface water and general deterioration. Due to the height and relative inaccessibility of the superstructure, no maintenance work has been attempted previously. In carrying out the repair operations only about 600 lin.ft. of one-half of the bridge is closed at a time, leaving two 11-ft. lanes for north and south traffic. At no time has the bridge been completely closed, and it is expected that the project can be completed without serious interruption to traffic.

Types of repair being done

Roadway and sidewalk slabs disintegrated beyond repair are being completely removed, the steel cleaned and that which has been reduced 10 per cent or more in area replaced with new steel. The slabs are then repoured with a 1:5 mix of maximum density.

The old bitumen-filled expansion joints (main joints at the piers and intermediate joints at the quarter points of the spans) were leaking badly and are being replaced with sliding plates attached with bronze bolts as shown in Fig. 5. Any leakage through the joints is collected in alloy steel troughs and carried to the curb where it drops into the down drain provided for scupper discharge.

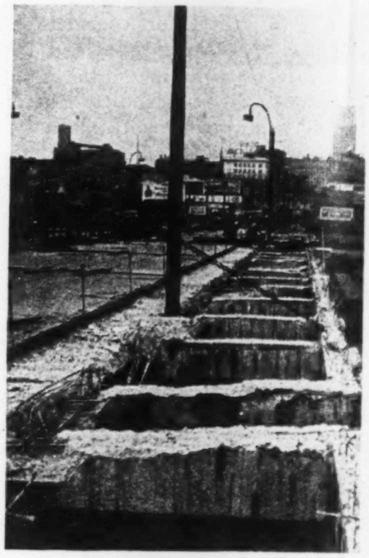

Fig. 1. Ready for new gutter, curb and sidewalk after old concrete has been chipped away.

The roadway slabs were carried at the expansion ends on reinforced concrete brackets on the crossbeams, bearing surfaces consisting of steel plates separated by lead sheets. Continual leakage through these joints

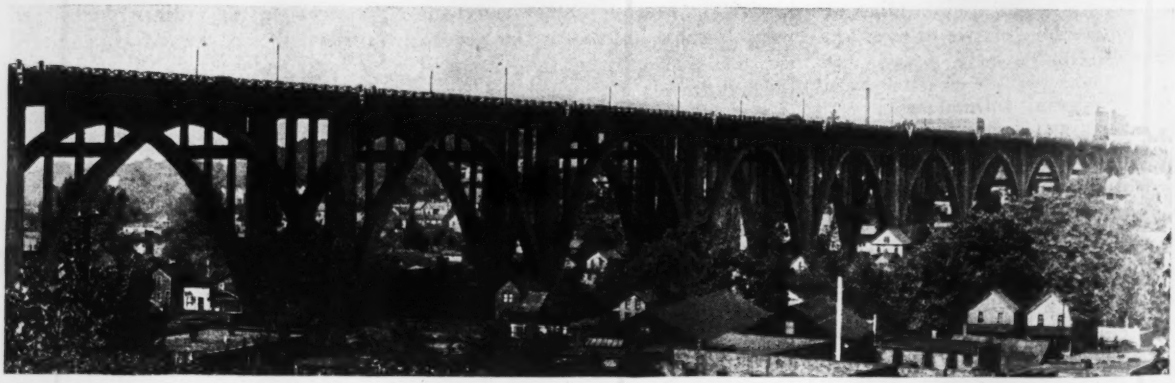

Fig. 2. Deck deterioration on the sixteen arch spans of Akron's North Hill viaduct required a major concrete repair operation which is being carried on from special scaffolds as shown in the accompanying illustrations.

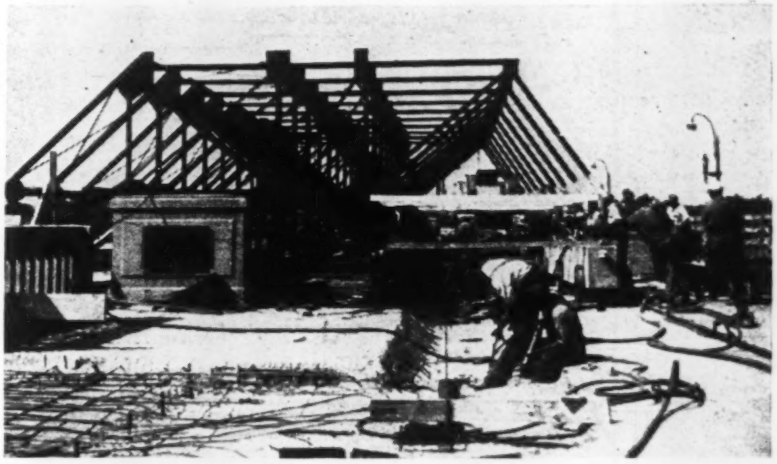

Fig. 3. Topside view of traveling scaffold. Workmen in foreground are chipping out bad concrete in advance of construction of new curb and gutter.

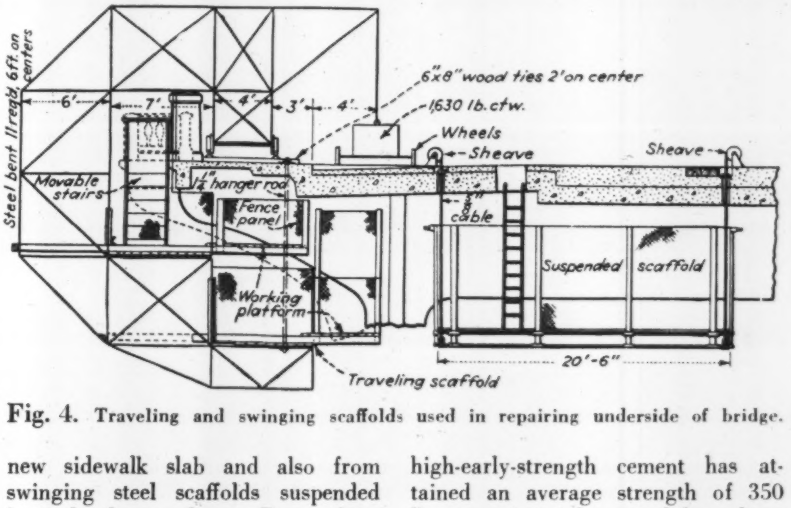

Fig. 4. Traveling and swinging scaffolds used in repairing underside of bridge.

had rusted and roughened the plates and many of them were inoperative. The brackets were also badly disintegrated and it was found necessary to remove and rebuild them. This has been accomplished by removing the brackets and chipping into the crossbeams to form a pocket for the new brackets. Expansion bolts are then placed and the bracket built back with successive layers of pressure concrete reinforced with wire mesh. A pair of cast leaded bronze plates is then placed on the bracket and the slab end rebuilt over them. During this operation the slab ends are supported by a beam assembly and bolt hangers supported directly on the main crossbeams as shown in Fig. 5.

The slab ends at most of the expansion joints are also badly disintegrated and are being cut back to sound concrete where ¾-in. lead sleeve anchor bolts are placed in sufficient number to transfer the stresses. These slab ends are then built back with pressure concrete after replacing disintegrated steel and cleaning the remainder by wire brushing. Repaired spots on the roadway are patched with bitumen surfacing to complete the job.

Work program being followed

In addition to the repair job all of the sidewalk slab and the curb are being removed as well as some of the roadway slab near the curb. All of the top deck operations are being carried out by a crew of workmen equipped with one 315-cu.ft. and one 210-cu.ft. air compressor; eight 80-lb. paving breakers and eight 30-lb. breakers. The two compressors also furnish air for the pressure concrete machine and for the two 30-lb. rock drills used for drilling holes for the lead sleeve anchor bolts. The work of this crew is followed by a carpenter and a concrete crew which installs wood forms for the new slabs and curbs, replaces the reinforcing steel and repours the slabs.

The under-deck operations are carried out by a third crew, also equipped with a 315-cu.ft. and a 210-cu.ft. compressor. These compressors operate the pressure concrete machine and a sandblast machine, ten 30-lb. clay spades equipped with moil points for chipping, two rock drills and several small paint spray outfits. This crew works on a special traveling steel scaffold suspended from the new sidewalk slab and also from swinging steel scaffolds suspended beneath the roadway. From these scaffolds the following operations are performed underneath the deck:

(1) Removal of forms placed by the first crew.

(2) Chipping disintegrated concrete on the underside of slabs, beams, piers, columns and arch rings.

(3) Sandblasting to remove loose material, dirt and to clean exposed steel.

(4) Drilling holes, setting anchor bolts and placing reinforcing mesh.

(5) Building up the chipped areas with pressure concrete to their original size and shape.

(6) Steam cleaning all areas to be waterproofed.

The pressure concrete mix being used is 1:3½ by volume. Mixing is done by ½-bag mixers, storage space being provided for but 3 or 4 batches at each machine in order to prevent loss of strength due to pre-setting of the cement. High-early-strength cement has been used in rebuilding the old brackets. Concrete made with high-early-strength cement has attained an average strength of 350 lb. per sq.in. at the age of three days, permitting the removal of forms and thus facilitating installation of expansion joints.

Two types of scaffolds

The traveling scaffold and the suspended scaffold are used together but are quite different in design. The traveling scaffold is supported on the sidewalk slab where it travels on small flanged wheels supported by railroad rails on wood crossties. It consists of 11 structural steel bents 6 ft. on centers, each bent being attached to a concrete counterweight at the roadway end to prevent overturning. A steel mesh fence attached to the steel members entirely incloses the working platform placed directly under the sidewalk slab, access being provided by a set of movable steps from the sidewalk level. The scaffold is designed for a 15,000-lb. live

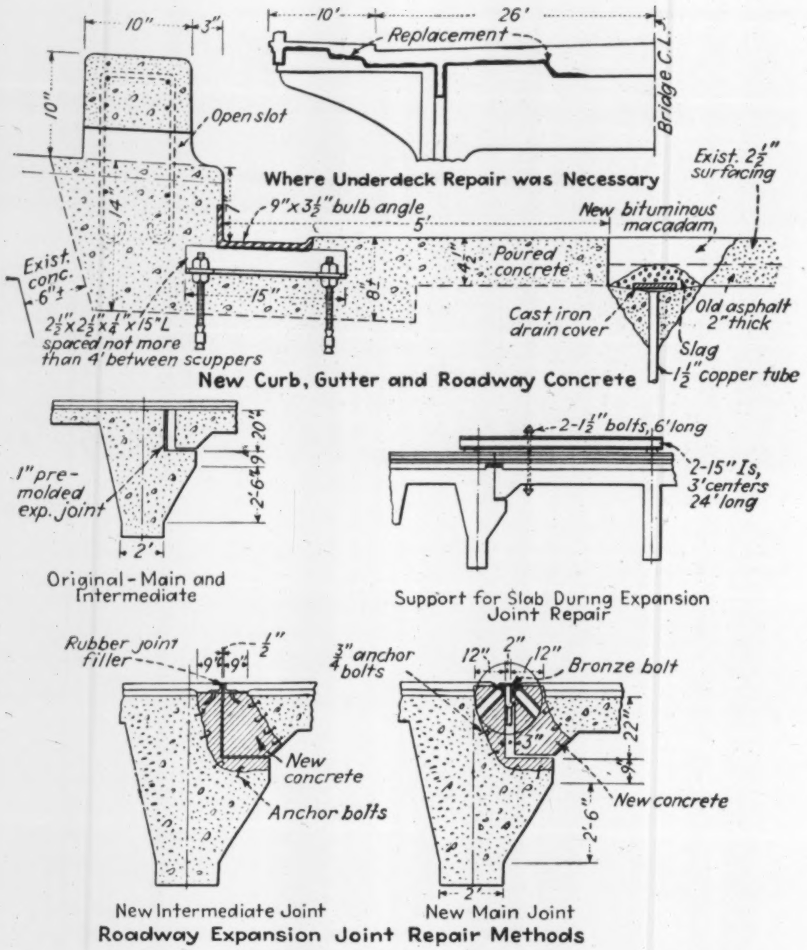
10"
3"
10"
Open slot
14"
Exist. conc. 6"±
2½"x2½"x¼"x15"L spaced not more than 4' between scuppers
9"x3½" bulb angle
15"
5'
8±
4½
Poured concrete
New bituminous macadam
Exist. 2½" surfacing
Cast iron drain cover
Old asphalt 2" thick
Slag
1½" copper tube
New Curb, Gutter and Roadway Concrete
10'
26'
Replacement
Bridge C.L.
Where Underdeck Repair was Necessary
1" pre-molded exp. joint
20"
9"
2'-6"
2'
Original - Main and Intermediate
2-1½" bolts, 6' long
2-15" Is, 3' centers 24' long
Support for Slab During Expansion Joint Repair
Rubber joint filler
½"
9"
9"
New concrete
Anchor bolts
New Intermediate Joint
¾" anchor bolts
12"
2"
12"
Bronze bolt
3"
22"
9"
2'-6"
2'
New concrete
New Main Joint
Roadway Expansion Joint Repair Methods

Fig. 5. Typical repair details. New expansion joints are provided with drains to eliminate concrete damage from leakage. Efficient scuppers and drains are also a part of new curb and gutter design.

load plus 50 per cent impact and an allowance for an accumulation of chippings. With the scaffold completely equipped, the weight is about 72,000 lb. Upon completion of one section, the entire scaffold is moved ahead by means of a double-drum steam winch operated by compressed air. The counterweights, being on wheels, are pulled with the scaffold by means of an equalizing bar.

For repairing the roadway slab between the arch ring and the centerline and the crossbeams and the arch struts, swinging steel scaffolds supported by $\frac{5}{8}$-in. plow steel cables through $3\frac{1}{4}$-in. holes drilled through the roadway slab are used. Five of these scaffolds 12x15 ft. are supported adjacent to one another and rigidly connected to form a continuous platform 15 ft. x 60 ft. These scaffolds are raised from the ground level by an air hoist on the roadway deck. The swinging scaffold is kept adjacent to the traveling scaffold to facilitate the work and make it possible to do all pressure concreting in one area with one machine.

Waterproofing

The areas of the completed structure exposed to the weather are being treated with two coats of transparent waterproofing. These areas are first sandblasted to remove surface dirt and loose particles and then cleaned with live steam at 100-lb. pressure to loosen and remove dirt from the surface pores. The waterproofing used is a synthetic resin and tung oil product, which is practically colorless so that it only slightly darkens the concrete and does not change its natural texture and appearance. This waterproofing is being applied in two coats by air brushing, only enough material being used to fill the surface voids. Spraying is discontinued as soon as the material begins to show up on the surface. The first coat is applied sparingly and allowed to dry for at least 24 hr. Surface voids are thus only partly filled, when this material dries it prevents the second coat from penetrating too deeply into the concrete.

This repair project is being carried out under a WPA grant, all labor except for skilled nozzleman being provided by the Works Project Administration for whom Charles R. Sharp is district engineer, E. Lloyd, area engineer and S. C. Breen, job superintendent. For Summit County, Arthur F. Ranney is county engineer, G. A. McChesney is superintendent and the writer has been in charge of design and field operations.

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Oil Strike Means New Water Reservoir

Finding itself in the unusual position of having oil wells under its water supply reservoir, Centralia, Ill., is on the lookout for a new reservoir site. Thus far it has succeeded in preventing contamination of its present supply.

Centralia is situated in the Salem oil field, largest in Illinois and second largest in the country. During the winter of 1938-39 oil got into the water supply through pipes which were broken by the cold. Some oil also got in the supply when wells on shore (one of them about 30 ft. from the lake) blew in. The city met this emergency by spreading straw, and by means of a speed boat drawing both the straw and oil back to shore.

But despite these emergencies, the water has never become really contaminated. Since there is great possibility of pollution, however, the city has acted upon the recommendation of the state sanitary engineering division to seek a new supply.

A new site was selected and the city started taking options on land, when a well on the new watershed proved productive, and landowners hoisted their prices. Seismograph surveys have shown, however, that the area immediately around the proposed reservoir does not have oil, and possibly the site may again be available.

Meantime, the city has been considering other possibilities. One is to build a pipe line 12 miles to the Kaskaskia River, which now supplies Vandalia, Carlyle, and New Athens. The other is to develop a reservoir south of town on Raccoon Creek.

Army and Navy Fee Construction Contracts

Contents in Brief—*Two forms of agreement for negotiated contracts define items chargeable to cost and fee respectively and set forth provisions for transportation, cancellation, dispute and subcontracts. Navy places officer on contractors' board to establish virtual partnership in contracts. Army's subcontract form is also given.*

FORMS OF NEGOTIATED CONTRACTS devised for emergency defense construction have been worked out by both Army and Navy. As these contract forms, one of which already is in use on large Navy contracts, are likely to control much government construction under present conditions, their principal provisions are briefly abstracted below:

Army's emergency fee contract

Time of Completion—Specified as the "shortest possible time." A detailed cost estimate is to be agreed on by government and contractor and a time of completion estimated, but the contractor does not guarantee the cost or time.

The work may be increased or decreased by the government as developments dictate.

Quality of Materials and Work—Materials are to be of best quality unless otherwise authorized, and construction is to be done in best and most workmanlike manner.

Payment to Contractor—The contractor is to be paid for all expenditures, for rental of his own equipment, and a fixed fee, the amount of which is stated in the individual contract.

Reimbursable Cost—Reimbursable cost includes all labor, material, tools, services, power, fuel, plant rental, loading and unloading and transportation of plant and materials, salaries of field employees, transportation and traveling expenses, land rentals and easement, field buildings and equipment, operating costs of facilities (except commissary), bond and policy premiums, social security payments and other taxes, fees or charges including license fees and royalties if approved, transportation of general officers and work done in the contractor's general office directly chargeable to the job, and other expenses or costs allowed by the contracting officer.

Rental of Contractor's Plant—Plant items costing less than $300 are direct expense.

Rental of hired plant is to be paid according to a rental schedule attached to the contract. Title may be acquired by the government as for the contractor's own plant.

The contractor is to be paid rental for his own plant at schedule rates, until the total rental equals the agreed valuation plus 1 per cent per month of use, after which title shall pass to the government; the government may buy any item of plant by paying the difference between valuation plus 1 per cent per month and rentals theretofore paid.

Fixed Fee—The fee is to cover the contractor's services, general overhead and profit, and is to be written into the contract.

If the amount of work is materially increased or decreased, the fee is to be equitably adjusted and the contract modified in writing; if the parties fail to agree the matter may be appealed (see *Disputes*, below).

Purchases by Government—The government may purchase materials, tools and equipment and may pay freight charges and labor wages direct.

Wages—Wages must be paid at rates not less than those established by the Secretary of Labor for the work specified. If the contractor or a subcontractor pays a higher rate the increased wage shall be at the expense of the contractor.

Termination of Contract—The government may terminate the contract for the contractor's delay, default or lack of diligence, or for the convenience of the government. If the government takes over and completes the work because of default by the contractor, it will reimburse the contractor for previous expenditures less unsettled claims. If the contract is terminated for the convenience of the government, reimbursement may include expenditures after termination for protection of property and for accounting services in settlement.

Disputes—Questions of fact under the contract are to be decided by the contracting officer, subject to appeal to the chief of the branch doing the work (Quartermaster General or Chief of Engineers), whose decision shall be final for items less than $15,000; for amounts over $15,000 further appeal to the Secretary of War is authorized.

Discounts and Revenues—All discounts and all commissary revenues over operating expenses shall be credited to the government.

Title to Materials and Works—Title to all work, completed or not, shall be in the government; title to all materials, tools and equipment other than rented equipment shall vest in the government on delivery at the site of the work or at an approved storage site and acceptance.

Time of Payment—Reimbursement of costs will generally be made weekly but may be made at more frequent intervals if warranted. Plant rental is to be paid monthly. Payments of 90 per cent of the fixed fee as accruing pro rata to work done are to be made monthly, the unpaid balance to be paid on final acceptance of the work. If the contract is terminated for the convenience of the government, such part of the unpaid balance of fee will be paid as the work done is of the entire project. If the contract is terminated due to the fault of the contractor no additional fee payment will be made.

Acceptance of the completed work is to be made by the contracting officer with reasonable promptness. Release of claims by the contractor may be required before final payment, but the contractor may specifically except certain claims.

Accounting—The contractor's records and books of account must show actual costs and must be satisfactory to the contracting officer, who is to have access to them at all times. The contractor may examine the contracting officer's books.

Special Requirements—Bonds and insurance may be required. The contractor is to procure permits and licenses, and abide by all applicable federal or local laws and ordinances, including safety and compensation. Contracts for services, materials or equipment are to be in writing if over $2,000. Subcontracts must have the contracting officer's approval.

Domestic articles must be used with specified exceptions. No convict labor may be employed.

This contract form was approved by the Secretary on July 12, 1940.

Navy's partnership contract

For construction of the Bureau of Yards and Docks of the Navy, a cost-plus-fixed-fee contract form has been worked out which aims to make government and contractor partners in the enterprise. The first contract under this form was executed on Aug. 5, 1939; others have been executed subsequently. They have been highly successful in operation.

The essence of the partnership arrangement consists in placing an officer of the Civil Engineer Corps, U. S. Navy, on the board of directors or other administrative boards or committees of the contractor to coordinate efforts and promote mutually beneficial relationships. For further centralization of direction, it is required that the contractor shall designate an operating committee of three persons to have complete charge.

Scope of Work—The work to be done is shown by general drawings and its approximate cost as estimated by the bureau is stated in the contract "to indicate generally the degree of magnitude and not as a limit of cost."

The contractor is to make plans and specifications.

All costs excluding interest on money and general overhead are reimbursable.

Subcontracts require approval.

Time of Completion—The time of completion is stated in the contract, but may be extended.

Increase or Decrease—The government may increase or decrease the amount of work as may be found necessary or desirable in the interest of the national defense.

Construction Plant—The contractor is to provide all construction plant. Rentals for equipment owned or controlled by the contractor are to be calculated on the basis of full cost without profit and for major items are to follow an agreed-on schedule attached to the contract. No deduction is to be made for idle time. In case of loss or major damage to plant or materials due to the contractor's fault while in transit, a board of naval officers is to investigate and recommend action to Congress.

Labor—Wage rates shall be fixed by the contracting officer and work is limited to 8 hours under penalty.

No convict labor may be employed.

Material—The contractor is to buy material. Domestic articles only are to be used. The government may undertake transportation of the material or of equipment, at its risk.

Quality of Materials and Work—All materials, equipment and workmanship to be of the best grade of the respective kind for the purpose. Inspection or tests as well as examination of completed work by removal are provided for.

Adjustment of Fee—Changes in the work that cause a material increase or decrease in amount or in time required may warrant adjustment of the amount of the fixed fee, the contract to be modified in writing accordingly.

Termination of Contract—The government may terminate the contract either for the fault of the contractor or for its own convenience on making due settlement.

Disputes—Disputes on facts under the contract are to be decided by the contracting officer subject to appeal to the Secretary of the Navy.

Commissary — Commissary and recreational facilities shall not be operated on a profit-making basis.

Time of Payment—Weekly payments of costs and the contractor's fee are to be made. Up to 10 per cent of the fee may be withheld pending completion.

Miscellaneous Provisions — The government may waive a performance bond requirement. The contractor is to obtain all licenses, permits, etc. The accounting is to be on a prescribed basis subject to examination by the government officials. Patented articles may be used only with approval. The contractor is required to police and guard the work, the cost of this service being part of the reimbursable cost.

Army subcontract form

A standard form of subcontract has been prepared for use with the Army fixed-fee contract. As approved Aug. 1 it provides for a fixed fee independent of the general contractor's fee. However, Army officials expect that subcontracts may be let either on fixed fee or on competitive bids, depending on conditions and time available; in either case the total payment to the subcontractor will be treated as cost to the general contractor.

Principal elements of the fee subcontract form are:

Time of Completion—Job to be completed in shortest possible time. Estimated cost and time are to be agreed upon and stated in the subcontract but are not guaranteed by the subcontractor.

The scope of the subcontract may be changed at any time by the contractor's written order, and if the change involves material increase or decrease in required work or time the fee is to be adjusted.

Quality of Materials and Work—Quality is covered by the subcontractor's obligation to comply with all terms of the general contract.

Payment—The subcontractor is reimbursed for all expenditures and rental of his own equipment in the same manner as the general contractor, and is paid a fixed fee (to be stated in the subcontract).

Cooperation with Others—The subcontractor is required to cooperate with other contractors or subcontractors engaged in government work at the locality covered by the principal contract.

Termination — The subcontract may be terminated in the same manner as the general contract and under the same terms of settlement.

Assignment—Assignment or transfer (except to the government) is forbidden. Subletting of any part of the subcontract is permitted only under unusual circumstances, on a fixed price and with written approval.

General Obligations—The subcontractor assumes the same obligations to the contractor as those assumed by the latter under the general contract, and grants to the contractor all rights and powers reserved to the government in the general contract.

Replanning Our Cities for Living

EMERSON GOBLE
Editor, National Real Estate Journal, Chicago

***Contents in Brief**—How to stabilize populations in American cities, the various factors involved and the consequences if we do not aid the agencies now at work are covered by an editor from a field little recognized by engineers but which is of vital concern to their livelihood. Since the engineer will have a large part in planning and rebuilding our cities the realtors' views will interest him.*

IT IS HIGH TIME to stop the decentralization of American cities. It is time, too, to develop some workable plans for rebuilding our cities, to plan for their stabilization, to make them more attractive places in which to work and live, to conserve the tremendous investments we have in them and to stabilize their municipal finances. That's quite a job, and many highly intricate problems are involved, but they all come back to the central one of replanning and rebuilding them for better living.

Herbert U. Nelson, executive vice president of the National Association of Real Estate Boards, develops the idea thus: Cities must be planned for the comfort and welfare of human beings. In pioneer days cities were built for workshops. Now we must rebuild them for living.

Most of the thinking centers around the automobile and its effect of widening our horizons. We speak of traffic jams, parking problems and high speed highways and say that the automobile is draining the population from our cities. The automobile has greatly accelerated the decentralization movement, but wasn't the movement already begun before the automobile became a factor in it? Aren't we just assuming that people do not want to live in our cities, and that the automobile and our new highways make it possible to live outside? Suppose we reverse it. Suppose all suburbanites wanted to live in the city. Then wouldn't the automobile and the highway be just as much a boon to the city dweller as to the suburbanite? In short, our highway and rapid transit systems would not be such decentralizing influences if we really wanted to live in the city in the first place.

Look around any large American city today and many things people dislike are found, things that drive them out farther and farther from the center of the city. Things like slum areas and blighted, half-deserted districts encircling the downtown area. Senseless conglomerations of industrial plants, business buildings and residential streets, all thrown together without rhyme or reason. Areas blighted by racial mixtures. Unnecessary crowding and congestion, based on fallacious concepts of land values. Smoke, noise, unsightly buildings, streets barren of foliage or flowers. All the handicaps of cities that, like Topsy, "just growed."

Make cities livable

Yet people do want to live in the cities, close to work, to shops and amusements. They would like to be within walking distance, not just driving distance. If we could make our cities sufficiently livable, certainly we could reverse the decentralization trend.

Moreover, now that American cities have reached the end of their wild expansion era we can begin to think about stabilization. We can plan not only for more beautiful and more pleasant cities, but also integrated, logical cities. And we can have some assurance that if our plan is effective it will be reasonably permanent.

It's not a new idea. It is, however, an ambitious one—maybe it's only a wild dream. But it is also beginning to look like a necessity, if we are to avoid chaotic conditions in our large cities. Maybe it will take fifty years, maybe a hundred. It will require the assimilation of some new concepts of engineering and economics and even of property rights. It will require a great amount of tearing down and re-

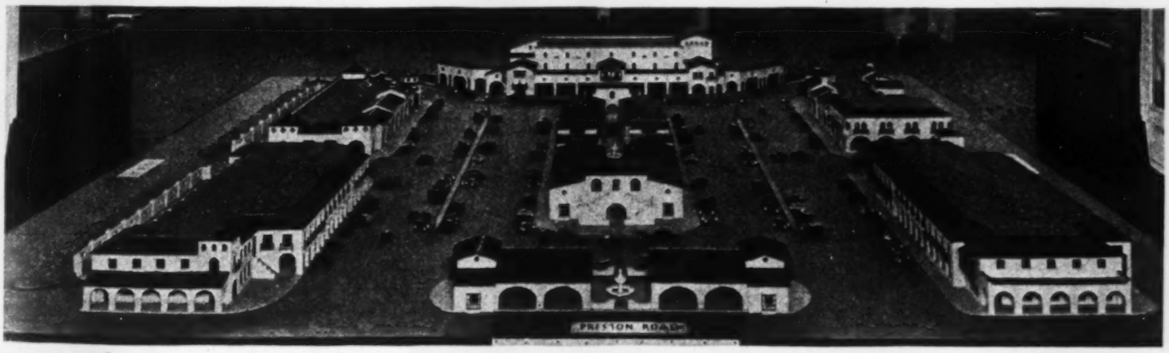


Fig. 1. **Model of a suburban shopping center in Highland Park suburb of Dallas, Tex., showing the 500-car parking facilities. Located at the intersection of two heavily traveled streets, none of the buildings faces on them. Loading zones are at the back of the stores screened from the street and residences across the street by a wall and heavy planting.**

building—new buildings, new highways, new parks and all other municipal services. But why should we bemoan the lack of geographical frontiers or new industries as business and employment opportunities, when right within our own cities we have such a job as that to be done?

Many phases of the task are currently being attacked by the several agencies closest to each individual problem. We are all familiar with such principal ones as: (1) traffic, including in addition to traffic control and regulation, highway construction, street widening, grade eliminations, parking facilities and public transportation; (2) slum clearance; (3) rehabilitation of blighted areas; (4) protection of central business districts; (5) new residential building; (6) parks and playgrounds; (7) zoning for business and industrial sections; (8) municipal financial problems.

These problems and campaigns of the times take on added interest if we look at them in relation to the central theme of replanning our cities for living. In some of them we find considerable progress already made, all helping to improve cities. In some we find evidence of too much concentration on the individual problem, without regard for any over-all plan, with the result that some day it will have to be done all over again.

Obviously what is needed is a comprehensive city plan, one broad enough to encompass all the problems and sound enough to answer them. This is not city planning in the ordinary meaning. In this sense city planning embraces much more than making a city map showing traffic routes and some other items. It contemplates not an advisory board to make routine studies and reports but rather an authoritative body empowered to initiate sweeping improvement programs and to exercise some control over land uses. A city planning commission able and powerful enough to start active efforts to remove the city's sores and blemishes—to rebuild it for better living.

A quick review of the current thinking on some of the separate problems involved will serve to clarify the general problem somewhat. At least it will give some idea of the task of coordination and planning.

Traffic and transportation

In our effort to promote safety, stop signals originally designed to accelerate traffic cut street capacities and speeds at least in half. Women dislike to drive downtown and downtown property values are on the wane. Street car routings all too often are through the center of congestion rather than a couple of blocks away.

We all see the need for more parking space in central business districts, but realtors point out that each time a building is destroyed to provide a parking lot, the attraction to the neighborhood provided by the former tenants of that building is lost. It is grouping together of many such tenants that sustains congested centers and high values.

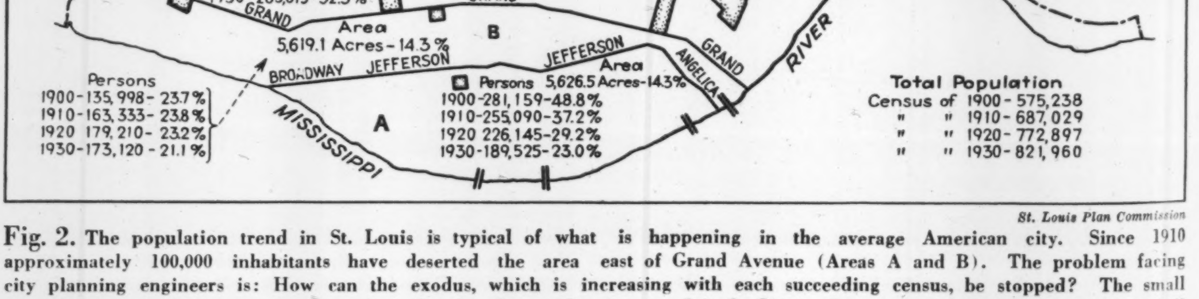
Just as the automobile caused blight of residential areas a similar effect is now apparent in blighting retail business districts.

It has been pointed out also that even the outlying business districts are already suffering the same blight as the central areas. Most of the subcenters have parking problems, too, and are losing customers to still newer areas where parking space is provided. So there are shifts in outlying business districts, as well as decentralization, to be considered in the city planning.

Downtown districts

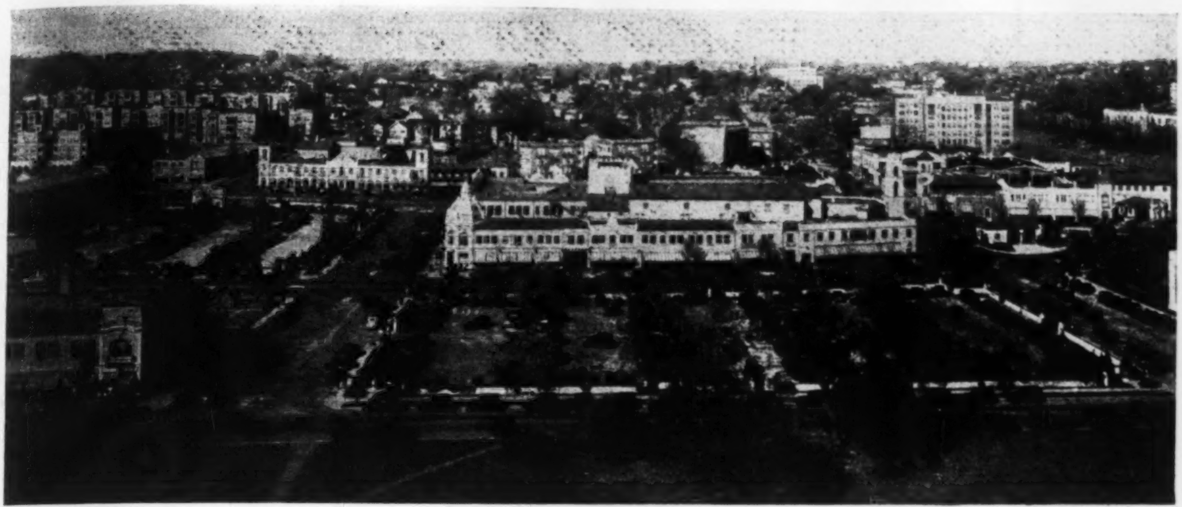
A beginning program for saving the present huge aggregation of real estate values downtown was sketched recently by a special committee of the National Association of Real Estate Boards.

Aside from face lifting in the way of store remodeling are initial suggestions made by the committee which is opening a long-term study of the economics of business-area planning in all types of commercial districts. The following points are emphasized: Every city should make a complete real estate inventory and keep it continually current; traffic conditions should be studied by experts as part of the planning work and satisfactory provisions made for arteries, public


CITY LIMITS
Persons
1900 - 41,869 7.3%
1910 - 92,251 13.5%
1920 - 138,485 18.0%
1930 - 193,700 - 23.6%
D
Area
15,202.0 Acres-38.7%
CITY LIMITS
GRAVOIS
KINGSHIGHWAY
KINGSHIGHWAY
Scale in Feet
0 4000 8000 12000
Persons
1900-116,212-20.2%
1910-176,355-25.5%
1920-229,057-29.6%
1930-265,615-32.3%
C
Area
12,829.2 Acres-32.7%
CALVARY
GRAND
GRAND
Area
5,619.1 Acres-14.3%
B
GRAND
RIVER
BROADWAY
JEFFERSON
JEFFERSON
Area
ANGELICA
Persons
1900-135,998-23.7%
1910-163,333-23.8%
1920 179,210-23.2%
1930-173,120-21.1%
Persons 5,626.5 Acres-14.3%
1900-281,159-48.8%
1910-255,090-37.2%
1920 226,145-29.2%
1930-189,525-23.0%
A
MISSISSIPPI
Total Population
Census of 1900-575,238
" " 1910-687,029
" " 1920-772,897
" " 1930-821,960

St. Louis Plan Commission

Fig. 2. The population trend in St. Louis is typical of what is happening in the average American city. Since 1910 approximately 100,000 inhabitants have deserted the area east of Grand Avenue (Areas A and B). The problem facing city planning engineers is: How can the exodus, which is increasing with each succeeding census, be stopped? The small area figures on this map show conclusively the decentralization trend in St. Louis. It is expected that the 1940 census will show a still greater exodus to the suburbs.



National Real Estate Journal

Fig. 3. **This 10-block plaza in Kansas City, Mo. is the main shopping center of the Nichols Country Club District, one of the foremost examples of scientific planning wherein all buildings, streets, parking areas are laid out to develop maximum retail possibilities.**

transportation, parking facilities and bypasses around congested areas; the relationship between pedestrian traffic and buying should be determined; the conclusions arrived at by determining the correlationship will have almost the force of economic laws; measures should be advocated for improving attractiveness, whether by way of removal of unsightly signs, or by remodeling and limitation of building heights.

Slum clearance

In no part of the problem has there been more confusion, more argument and more prejudiced thinking than in the realm of slum clearance, for the slum disease breaks out in many different ways. Probably no other part is less susceptible to solution by itself, without reference to an integrated city plan, and yet that is just what is being attempted in so many slum clearance projects.

Certainly there are many good reasons for the government's attacking this problem, and no doubt there are reasons for building relatively expensive apartment buildings for the poor people in slum districts. But when one considers not a few isolated building projects, but the eventual solution for a whole city, one soon finds many shortcomings in the federal projects so far seen.

One of the major difficulties the housing authority has faced in its task is high land values in the blighted districts. And one result has been to drive housing authorities out farther from the heart of the city, even out to vacant land. Certainly this does nothing to clear slums, or to combat decentralization.

The hurdle of high land values is another reason for a comprehensive city plan. With a plan worked out covering land uses throughout a city, land values would tend to be fixed in accordance with the plan, and land prices would almost automatically come within reasonable bounds. Or perhaps the city plan commission would eventually be given such specific authority that directly or indirectly it could regulate land values.

Last year the Illinois legislature considered, and rejected, a "public service building corporation" plan that would, under certain conditions, give the power of condemnation under eminent domain to private limited-dividend corporations set up to clear slums and rehabilitate slum buildings. It's a pretty advanced thought and contains obvious dangers, but some such principle might eventually be accepted.

A significant recent development is the insurance by the Federal Housing Administration of a loan for rehabilitation of old buildings in Philadelphia. Such a plan can show widespread results much faster than any program of new construction. Incidentally, the National Association of Real Estate Boards is making city planning and decentralization problems an important item in its program for the year, and is presently engaged in setting up an Urban Land Institute for research in this field.

As the building cycle moves closer and closer toward a peak of building volume in the residential field, there is more need to be sure that hit-and-miss developments do not further confuse a city's development. New residential construction is almost entirely in the outlying areas, with a consequent decentralization effect. While probably little can be done about that in this particular period of building construction, there has been considerable concern in real estate circles about the building of "shanty towns" just beyond the city's limits. At the very least new building developments in outlying areas offer real competition to the city itself.

Zoning could be effective

Zoning has frequently been called a "failure." And the practice of zoning as it has worked to date may justify that designation. But zoning has not contemplated such a comprehensive study of cities as we have been discussing in this article. It has embraced only the most limited control of land uses, and has been used too largely for selfish purposes. Zoning, or some form of it, could be very effective if behind it there were some comprehensive, constructive plan.

All in all, it becomes a problem of competition between city and suburbs. The eventual answer is not the obvious expedient of taxing suburbanites that earn their living in the city and do their spending outside. It is simply a problem of good business—keeping the customers they still have and winning others back.

Running Track Designed From Scratch

W. E. Cullinan, Jr.
Portland, Me.

A running track recently constructed for Deering high school at Portland, Me., is believed to have interest because available literature gave no guidance to design and an inspection of local school and college board tracks indicated no prevailing standards. Starting at scratch then, the writer worked out his own design. Talk with athletic instructors and track coaches developed some general principles: Rigidity is to be avoided because it gives runners shin-splints; flexibility or springiness is vitally necessary but an excess is to be avoided; uniformity of springiness is necessary—that is, no hard and soft spots at and between supports. Common faults are bad turns and exposed nail heads in the floor.

Construction features

With these requirements in mind the structures shown by Figs. 1 and 2 were built. They are a 12-lap circular track and a 210-ft. dash track. All dimensions are shown by Fig. 2. For the lap track, creosoted oak posts were set 4½ ft. into the ground exactly as indicated on the foundation plan. The posts were then marked and cut to grade and 4x6-in. oak caps were pinned into place. By care in marking the posts with instrument and tape, shims were made unnecessary.

The inside 4x4-in. spruce curb was then placed, using straight lumber and jacking the ends to fit the arc on the turns. The laminated 2x3-in. spruce floor then followed; door clamps were used to spring the lumber while it was being spiked on the turns. When the full 10-ft. width was built up the outside curb was bolted in place. Levels taken on the inside curb after completion showed less than ½ in. variation from a level grade around the track.

The bank of the track on turns is figured for a speed corresponding to a mile in 4 min. 15 sec. Thus the bank provides for a fast mile, good one-half mile, and slow one-quarter mile speeds. At turns a transition is effected by breaking from a level straightaway, about 19 ft. ahead of the P.C., and gradually reaching the full bank of 3¼ in. per foot about 21 ft. beyond the P.C. The bank on the turns appears very steep compared with other tracks but pictures of famous mile runners taken on turns indicate the body leaning inward and a bend of the ankle that prove insufficient bank on those tracks.

The feature of staggered joints, lumber laid with grain in direction of motion, and complete lack of nail heads, is also worthy of note for desirable running qualities.

The adjacent dash track was similarly constructed using three post bents for the 18-ft. width and crowning the caps 1 in. The floor is laminated construction with 4x3-in. curbs chamfered to facilitate drainage, a requisite for low maintenance cost.

The costs of building the two tracks are: labor $2,844; material $1,336, total $4,180. This cost includes incidental grading of the area, loaming, seeding, drainage, etc., but material cost excludes cost of posts and caps, which were donated from another project, and cost of loam, which was obtained from an excavation operation on another project. The work was done by the local WPA.

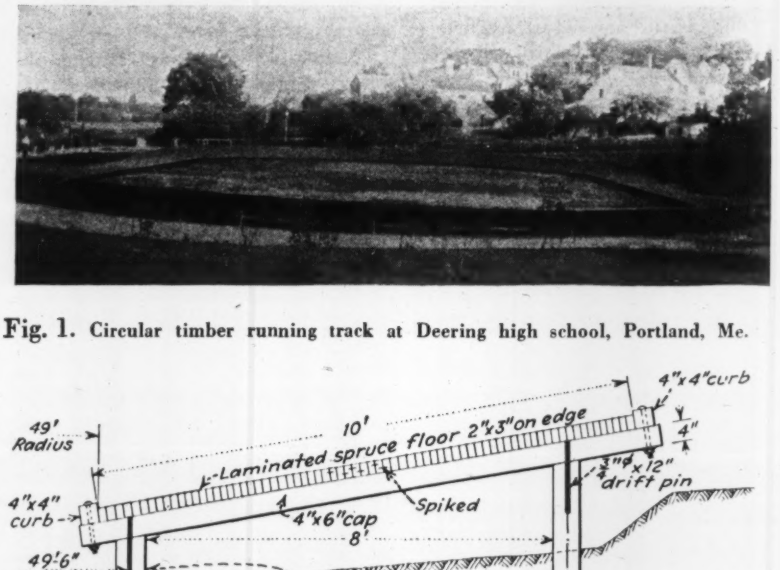


Fig. 1. Circular timber running track at Deering high school, Portland, Me.

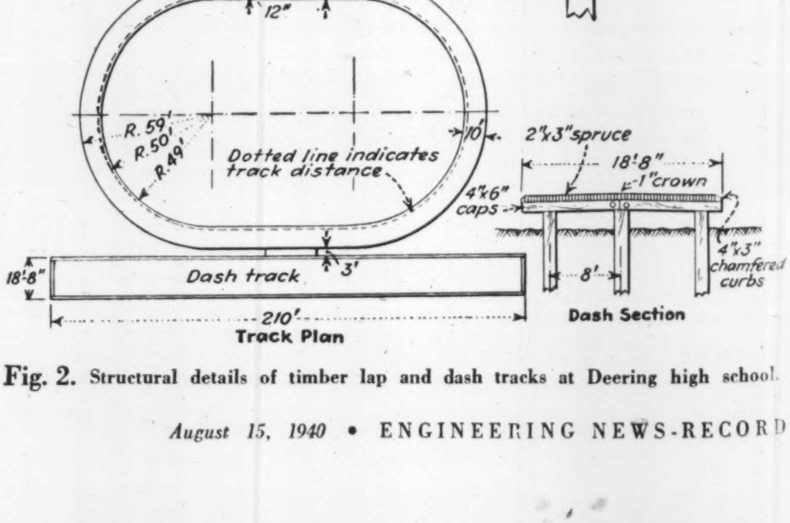


Fig. 2. Structural details of timber lap and dash tracks at Deering high school.

Electric Drive for Ordinary Jobs — VII

Direct-Current Drive for Power Shovels

GEORGE H. HALL
Mechanical Engineer, Douglaston, N. Y.

***Contents in Brief**—A shift from alternating current motors, more generally used for electric drive, to direct current motors for power shovels adds starting advantages, simpler control and greater durability of drive mechanism that more than compensate for the motor-generator conversion unit that is required. Development of control is constantly simplifying electric shovel operation. Self-contained motors and controls are widening the use of grab buckets.*

Two of the most commonly used excavating tools for which electric drive is particularly adapted are the power shovel and the grab bucket. The power shovel is a self-contained machine, powered and mechanized for all excavating functions and travel about the field of operation. In contrast, the grab bucket is a tool appended to a derrick or crane where either is used for excavating. In this article, electric drive is discussed first for the more important power shovel.

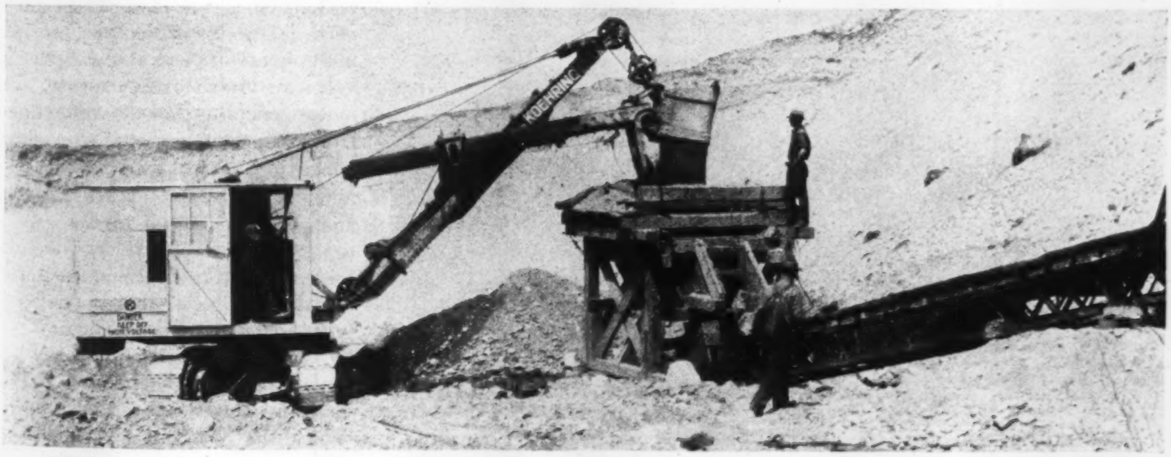
Electric shovel drive

In the operation of power shovels three distinct functions are involved which are: (1) the hoist movement by which the dipper or bucket, having been filled, is raised to the desired clearance height for swinging around to the discharge point; (2) the thrust, or "crowd" movement, by which the dipper stick or handle is moved out or in to reach the filling and discharge points, and to force the dipper into the earth in digging; and (3) the swing movement by which the entire cab and its mechanism are swung around between the digging and the discharging locations. The cab itself is mounted on a turntable carried on a caterpillar truck or "crawler," which is driven through clutch and gearing from the swing drive.

Comparatively small shovels are sometimes operated from a power unit similar to that of a derrick and require but a single motor, each movement depending upon the manipulation of clutches and gears. Such shovel may be driven by a constant speed motor; if for direct current, preferably of the compound wound type and if for alternating current, of the wound rotor type.

This practice represents the first step that was taken in the development of electrical operation of shovels and is still followed to a more or less limited extent. With this arrangement the motor simply replaces the steam or gas engine of the earlier types of shovels. Such a drive, of course, lacks the flexibility of that in which each movement is under control of its individual motor and is suited only to the lighter classes of work.

Motors for the individual units of a shovel are wound rotor motors but long experience has resulted in the general adoption of direct current rather than alternating-current equipment. Direct current motors provide better starting characteristics, less complicated controls and increased durability. Since most large projects are serviced with alternating current, the use of direct current apparatus involves the addition of a motor-generator. Such a motor-generator may be conveniently placed in the cab of the shovel where it is directly under the supervision of the operator and where only short leads to the various motors will be involved. The cost of this additional equipment is more than compensated for by the



National Equipment Corp. Photo

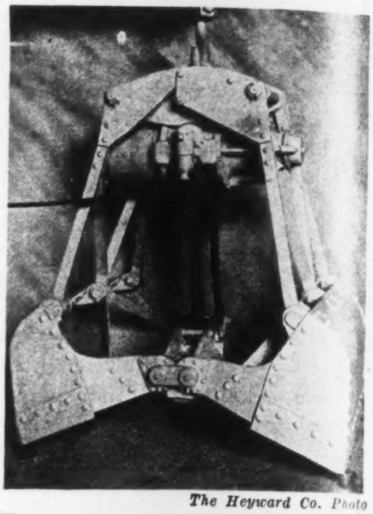
Fig. 1. **An example of a comparatively small shovel of the class still commonly operated by single-motor drive.**

increased advantages which it provides.

In the early designs of individual shovel equipment, series wound motors were employed, but this involved the use of rheostatic control with large resistors which were wasteful of current and also required making and breaking the main circuit to the motor for each reversal. The adoption of the generator-field control principle, although it necessitated a separate generator for each motor, provided a great improvement as it eliminated practically all of the heavy resistance, improved the efficiency and simplified the control. With this system the motors are series-wound and their speed is determined by the voltage of the current with which they are supplied by the generator. The generator has a differential series field which provides a drooping characteristic giving a high voltage, and consequently a high motor speed for light loads and a low voltage and consequently a low motor speed for heavy loads. Such winding also provides for stalling conditions at a predetermined torque at the motor shaft, thus protecting the gearing of the drive against ruinous overloads.

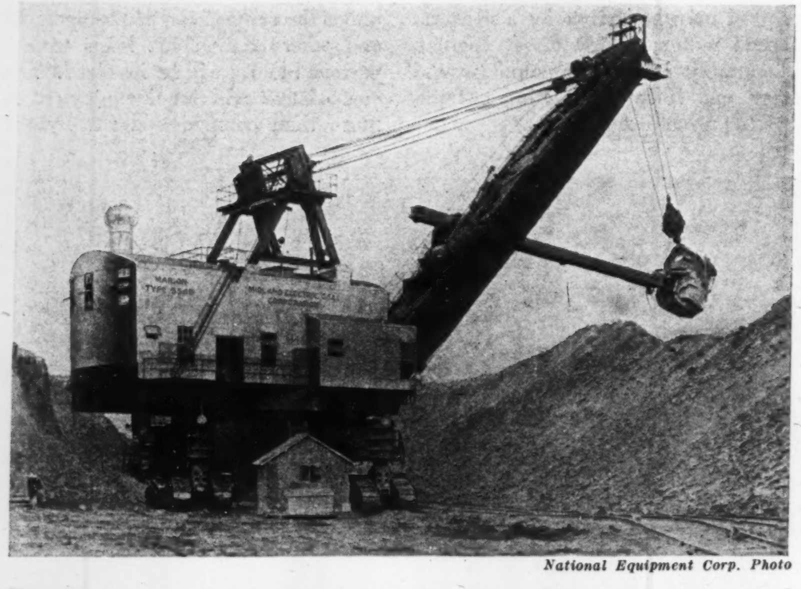
This development has been followed by the use of separately excited motors in place of series-wound which eliminates the necessity of handling the armature current on reversal, this being accomplished by simply reversing the motor fields. This system also improves the performance of the motors under plugging and regenerative-load conditions.

The most modern type of shovel equipment is operated on the voltage-control system which is a further modification of the field-control system described above. The voltage-control system involves the use of a separately-excited motor and a separately excited generator for each shovel movement. The armatures of the motor and generator units are connected in series. The generator voltage is controlled by the regulation of its separately excited fields and this voltage controls the speed of the motor, the fields of which are excited from a constant-potential source in the form of an independent exciter. As with the field-control system, the generator fields are differentially wound, resulting in the drooping voltage characteristics: that is, the generator will have a comparatively high no-load voltage which gradually decreases as the armature current increases until a stalling condition of practically no voltage is reached at some predetermined value of generator-armature current. The motor speed therefore varies inversely as the torque and will produce a heavy pull at slow speeds while its speed increases as the loads decrease.



The Heyward Co. Photo

Fig. 3. Grab bucket with operating motor and brake incorporated in the frame that can be hooked onto any conventional form of derrick or hoist.



National Equipment Corp. Photo

Fig. 2. Large shovel of the class used in coal mining and heavy excavation operated on the more modern voltage-control system with a separate motor for each operation and a separate generator for each motor.

Reversal of the motor rotation necessitates simply a reversal of the motor field current, which is of comparatively small volume, and involves no handling of the motor armature current at all. The entire apparatus for the control of each movement drive consists essentially of a rheostat for the control of the shunt field of the generator, and a rheostat and reversing switch for the fields of the motor. A rheostat is also needed for controlling the fields of the exciter, which supplies the exciting current for all of the motors and generators of the entire equipment.

Although this system involves a separate generator for each motor, there is a very material saving effected by the elimination of the heavy resistors and switches necessary with individual series-wound motor drives. To obtain the advantages of direct current drive one motor-generator is needed anyway so that the use of a multiple motor-generator does not involve an undue extra expense. The motor-generator for the voltage-control equipment consists of a single alternating-current motor which is mounted on a common bedplate with and direct-connected to the generators, of which one is provided for each movement. The main motor of the set may be of the squirrel cage type, but, if the set is of large capacity, a synchronous motor is always preferable, Direct-connected to the motor-generator shaft is also an independent generator to supply the necessary current for the excitation of all motor and generator fields.

On some of the larger sizes of shovels a torque motor is frequently provided for dumping the bucket instead of by the conventional hand tripping. Large shovels may also sometimes have a double-motor drive for the hoisting element but, as both motors drive drums on a common shaft, the two motors may be treated as a single drive.

Brakes for stopping and holding the various motions are operated by compressed air or by solenoids. The solenoids, in the form of mechanical brakes, are mounted on the individual motors and operate on the current supplied to the motor. For air-operated brakes, a compressor constitutes an element of the shovel equipment and this is driven by a constant speed motor which may be of the squirrel cage type, operated on the alternating current supply, or it may be shunt-wound to operate on the direct current supplied by the motor-generator exciting unit.

The boom of the shovel is generally raised and lowered by an auxiliary drum driven from the hoisting drive but, in some cases, an individual drive is incorporated in the equipment. Such a drive is driven by a constant speed motor.

Portable cables

The portable cable by which the shovel is supplied with current should be given careful consideration since it is exposed to the hardest kind of service by being dragged over the ground which is frequently rough and rocky. It must at the same time be sufficiently flexible for easy handling and for reeling on the cable drum in the cab. A variety of suitable portable cables are available and the selection will be governed by the severity of the service to be encountered. For general use an all-rubber type with tellurium-compounded jacket is usually satisfactory, since it is extremely flexible and is provided with a tough, abrasion-resisting jacket which is especially suited to rough usage. For more severe conditions the portable cable may be wire-armored, thus presenting greater resistance to abrasion but at some sacrifice of flexibility. Due to the additional weight of the wire armoring it is somewhat harder to handle than the all-rubber type.

If a motor-driven cable reel is employed it is driven by a constant speed motor which may be squirrel cage or shunt-wound in accordance with the current available.

Motor driven grabs

Grab buckets as used in construction work are employed mainly for excavating or for handling sand and gravel from the pile to the concrete mixer. When so used they take the form of a crane or derrick hoist in which the hoisting hook is replaced by the bucket while suitable provision is incorporated in the equipment to provide for the opening and closing of the leaves of the bucket. Boom raising and swinging are accomplished by the usual equipment of the derrick or crane. Each movement may be performed by the use of individual motor drives or from a bank of drums driven by a single motor and controlled by clutches and gears.

The amount of work on many construction projects which can best be performed with a grab bucket may often not be of sufficient volume to warrant the expense of a crane or derrick bucket as a separate piece of machinery even when it could for a limited time be used to a very considerable advantage. In such cases profitable use may be made of the "hook-on" type of bucket which is simply attached to the hook of any conventional type of derrick, hoist or cableway. With such a grab the hoisting and lowering is done with the regular hoisting cable while the activation of the bucket is accomplished by an individual motor which is built into the frame of the bucket. The electrical equipment of the bucket consists of a special type of torque motor, with suitable gear reduction and a brake which holds the bucket closed during hoisting and lowering. The control is an extremely simple form of handle-operated switch which is mounted in the cab of the hoist or crane and connected by flexible cable to the bucket motor.

When the open bucket has been lowered onto the material to be handled, a movement of the controller to the "closing" point causes the motor to run in a forward direction and, through intermediate gearing or chain drive, causes the bucket to close, thereby digging into the material until it is full and the halves brought close together. The special construction of the torque motor permits stalling with safety when full closing is accomplished. Current is then cut off and the brake holds the shells together while the bucket is being moved to the point of discharge. Reversal of the control causes the brake to release, the motor to run in the opposite direction, thus opening the shells and permitting the contents to drop. The bucket is then ready for another cycle of operation.

Timber Preservation Figures for 1939

Consumption of treated timber in 1939 aggregated the equivalent of 3 billion board feet, an increase of approximately 12,000,000 over 1938, according to a report prepared by the U. S. Forest Service in cooperation with the American Wood Preservers Association. Railway ties represented 44 per cent of the total; poles, 32; timber and lumber, 14, and piles, 6 per cent. In number of ordinary ties there was a decrease of 20 per cent. About 97 per cent of all ties were treated with creosote or creosote mixtures.

The number of poles treated was 4,634,793, an increase of 31 per cent over 1938. Of these, 78 per cent were pressure-treated and 32 per cent butt-treated. Piles also showed an increase of 70 per cent. Creosote was used for 96 per cent of the piles.

Distillate coal-tar creosote consumption totaled 105,800,000 gal., an increase of 11 per cent, but the consumption of both creosote-coal-tar solutions and creosote-petroleum mixtures showed a decrease, which is attributed to the smaller number of ties treated. Plain zinc-chloride also showed a decrease, while chromated zinc-chloride increased 41 per cent to a total of 2,600,000 lb. Creosote and zinc salts were used for the treatment of 98 per cent of all timber treated, with miscellaneous salts or liquids for the remainder. The amount of Wolman salts used was greater than in 1938, but there was a decrease of 3 per cent in board-feet of timber treated. Two new wood-preserving plants were built in 1939, and of the 229 plants 221 were in operation. Of these, 180 belonged to commercial concerns, 23 were owned and operated by the railroads and 26 by public utilities and mining companies.

Bridge Paint is Steam-Cleaned

When experience in repainting the San Francisco-Oakland Bay Bridge showed that preparatory cleaning averaged more than half the total cost of paint maintenance, a portable steam-cleaning unit was adapted to this service. This unit, said to be the first of its kind in bridge maintenance, has been so satisfactory that two similar ones have recently been added. Paint maintenance on this bridge, on which 110,000 gal. was applied under the original painting contract, constitutes a permanent job for about 45 painters. With this crew, the 15,000,000 sq. ft. of surface to be protected is to be worked over in five-year cycles. An earlier statement about paint maintenance on this project, published in *Engineering News-Record*, Aug. 17, 1939, p. 211, can now be supplemented as follows:

The condition of the painted surfaces to date is said to justify the initial preparation of the steel surface by thorough sandblasting. Thus far, paint failures have been of only minor sort and causes have been readily ascertained. Salt spray and SO_2 in the exhaust gases from diesel trucks have been the main causes of corrosion but only limited areas have been thus attacked and additional protection at these places is now given.

Coal tar products, substituted for metal oxide, protect against salt spray and a change in the formula of final coats to increase acid resistance thus far has met the SO_2 problem. The scheme of maintenance in general contemplates correction of paint film failure in its initial stages before the attack has penetrated to the steel.

Experience to date with the red lead and oil used for the first three coats of the original painting has been generally satisfactory. The slow-drying characteristic operates to reduce the amount of suitable painting weather for these paints but maintenance painting usually can be scheduled to overcome at least part of this objection.

Thus the lead-and-oil formula used for original painting is being used on maintenance. Experiment is being made with the addition of 2 to 3 lb. of a metallic lead paste per gallon of standard formula paints. After the 1½-yr. period of trial thus far, this shows much promise. About 1,000 gal. of the lead-and-oil paint has thus far been reinforced in this way.

The steam-cleaning machine which expedites the expensive cleaning process, is similar to equipment used in garages and industrial plants for cleaning greases, oils, etc., from automobile chassis and engines. The adaptation to bridge work includes making the outfit portable and permits working with hose lengths up to 200 ft. An essential feature of the rig is a boiler with a flash-type heating coil generating low-pressure steam. Hot water mixed with the steam in the coils acquires considerable velocity and is directed through hose and atomizing nozzle upon the surface to be cleaned. Of the 15,000,000 sq. ft. of painted steel surface to be maintained, it is estimated that the steam cleaner can be used on 60 per cent. This could probably be increased to 80 per cent were the hazard to traffic not a consideration.

A small amount of solvent added to the water expedites the removal of film and is effective even on coatings of foreign material "cemented" to the paint surface with road oils and greases. It is important that the solvents should not be injurious to the paint film in the proportions used. The solvent formula found most effective without injury to the paint surface, expressed in proportions by weight, is as follows:

Sodium metasilicate	45
Sodium sesquisilicate	42
Sodium tetraphosphate	10
Wetting agent (naccanol)	3
	100

Of this mixture, 12 lb. is added to 550

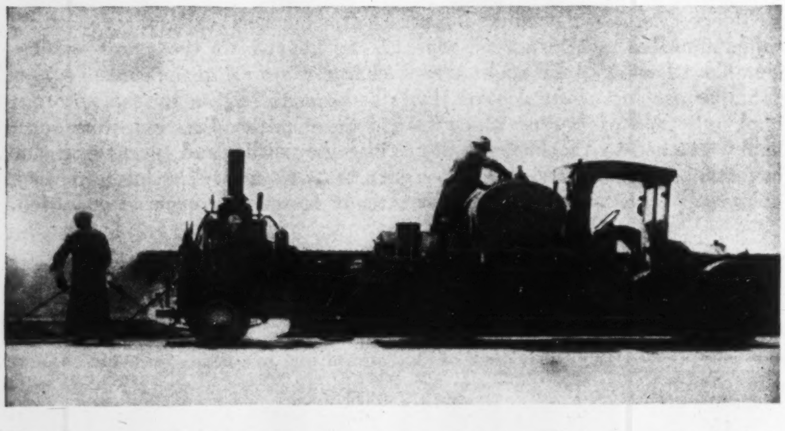


Fig. 1. Steam-cleaning outfit, on truck and trailer, working on approach deck.

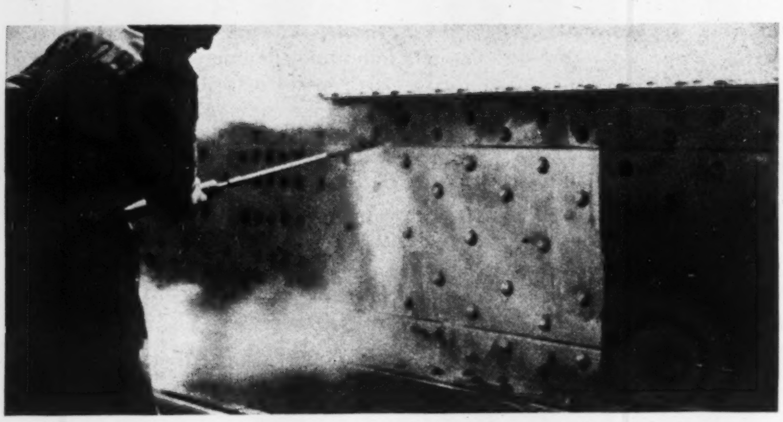


Fig. 2. Steam jet cleans better than the old style brushing method at one-fifth the cost. Note difference in appearance of surface before and after cleaning.

gal. water—i. e., a 0.25 of 1 per cent solution by weight.

Experience with the steam-cleaning method to date shows it (a) is very fast, (b) is much cheaper than brushing by hand with a stiff brush (costs about 1/5 as much, (c) produces a much cleaner surface for reception of paint, and (d) does not damage the existing film of good paint as sometimes happens with the stiff brushing method. Depending upon the accessibility and detail of the surfaces, 200 to 400 sq. ft. can be cleaned per nozzle per hour. Each machine is able to supply two nozzles although it is not always possible to work two at once.

The bridge was opened to traffic on Nov. 12, 1936, and hence maximum paint maintenance requirements will not be reached for another year or two. Paint maintenance costs budgeted for the fiscal year ending June 30, 1940, totaled $118,880. In this period 7,200 gal. was used.

C. H. Purcell is chief engineer of the California Toll Bridge Authority; Ralph A. Tudor is principal bridge engineer in charge of maintenance and operation; and C. S. Hamilton, associate bridge engineer, supervises the paint crews and developed the steam-cleaning procedure.

New Type of Rock Spreader Puts Facing on Earth Dam

A NOVEL ROCK SPREADER, designed and built at Hansen Dam where the requirement is for a 30-in. layer of quarry run (spalls up to 100-lb. rock) on a 1: 3 slope, was undergoing its try-out as this is written. The new spreader resembles a large trailer with a body that can be tilted, as in a dump truck. When loaded with 30 tons of rock, it is lowered down the face of the dam by a cable from an electric shovel standing on the berm or on the crest of the dam. When at the bottom of the slope, the device begins to discharge its rock load as it is pulled back up. The rate of discharge is regulated so that a layer 30 in. deep and the full width of the body is placed on the slope by discharge from the rear end of the dump body.

Two features control the discharge: (a) the body can be tilted by an amount that is adapted to various factors such as slope, speed of travel, size of rock, percentage of fines, etc. and (b) a power-driven roller resembling a long shallow machine gear rotates at the rear end of the dump body just above bed level. The projections or gear teeth on this roller are designed to encourage, by their uniform speed, a uniform movement of the outflowing rock. The gear teeth are not continuous for the full length of the roller but are in two halves with a slight open space midway. Alignment of the teeth in the two halves is broken at this center gap.

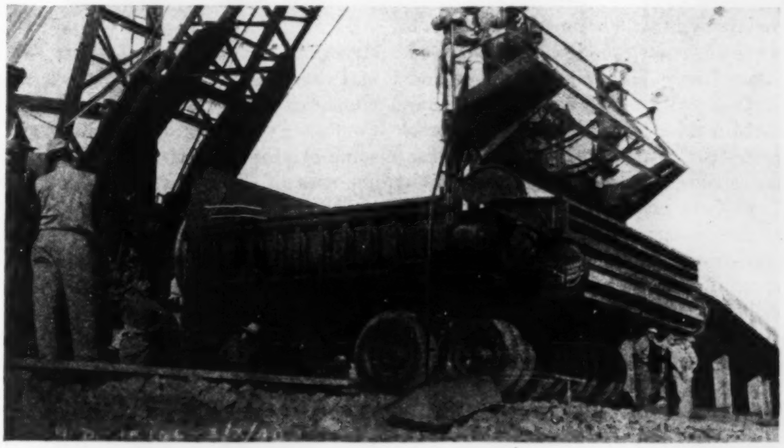


Fig. 2. Closeup of the spreader showing "gear teeth" in roller at read end. Operator's platform is adjusted to be level while the spreader is on the slope.

Each end of the geared roller is powered with a small motor and motors also are used for raising the heavy tail gate, for tilting the dump body and for operating the power steering mechanism. Power is brought to the spreader by a 400-ft. electric cable kept on a wooden reel at the forward end. This reel is spring-operated so that slack paid out when the downslope trip is made will be reeled in automatically on the return trip.

Material is dumped into the body of the spreader by trucks hauling from the quarry and backing up a timber ramp, kept near the spreading operation, to obtain headroom for gravity transfer.

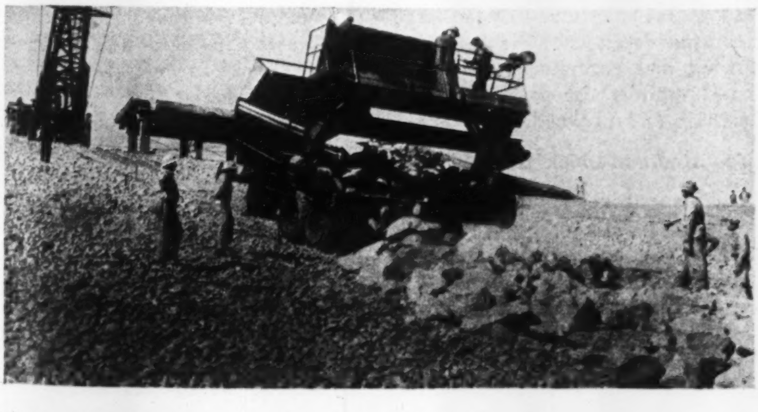


Fig. 1. Spreader discharging the 30-in. rock layer as it moves up the slope. Note dragline and portable ramp at top of slope in background.

Experience in Maintenance Of Large Timber Structures

JOHN J. GOULD

Constructing Structural Engineer, San Francisco, Calif.

Contents in Brief—Results of frequent and thorough inspections of heavy timber construction in exposition buildings at San Francisco in relation to shrinkage, checking and settlement. Comparison of old and new joint types emphasizes advantages of ring connectors for timber trusses. Satisfactory service of modern bold design for temporary buildings suggests that unit stresses could be safely increased 30 to 100 per cent. Further information needed on wind loadings.

FOR THE TEMPORARY BUILDINGS of the Golden Gate International Exposition at San Francisco, approximately 50,000,000 fbm of timber was used in construction, which included many heavy timber roof trusses and various types of timber joints of unusual bold design. Due to the large number of spectators constantly using these buildings, frequent and thorough inspections were necessary to determine promptly any dangerous checking, shrinkage or settlement. As a result of these inspections much valuable data was obtained leading to increased confidence in this type of timber construction. That practically all of the designs gave satisfactory service is evidence of their practical application for less expensive construction.

By reason of the temporary nature of these structures, usual timber stresses were increased 30 to 100 per cent and other expedients used which ordinarily are not employed on a large scale.

Three hinged arches were generally chosen for roof support because the average height of structure was 85 ft. This height was dictated by the need for ample clearance for exhibits and for architectural reasons in the arrangement of setback walls. Thus more than 1,000,000 sq.ft. of exhibit area was roofed over with timber arches whose clear spans ranged from 120 to 200 ft. Truss spacing varied from 30 to 40 ft. Most of the arch trusses were connected by purlin trusses set in radial planes and using Howe or rod-and-block joints, as shown by (a) in the accompanying drawing.

During the latter part of the construction period, the low first cost and ease of dismantling dictated the choice of more modern design, particularly ring-connector joints and some original design features. A palace area of 250,000 sq. ft. with clear spans up to 136 ft. was built with modern timber connectors. The members were interconnected by means of split rings, flush type shear plates were used with steel gusset plates, and in one special case there was a concrete block poured in place between steel gussets to take compression (*ENR*, Aug. 3, 1939, p. 158). In some large tower structures, a design made to fit the requirements introduced a strap-and-pin joint with flush-type shear plates (*ENR*, Aug. 4, 1938, p. 151). In many of the large structures, dependence for resistance to wind and earthquake loads was placed entirely in nails, diagonal sheathing and plywood.

Rod-and-block trusses

In inspecting timbers used in trusses of the rod-and-block type (in which a large amount of boxed heart timber was found to have been used), each timber was observed as a rule from three sides. Checks were found to have penetrated generally to about 1/3 depth of the timber, depending upon the location of the heart; the length of the checks in most cases extended the full length of the timbers. In one member of two main arches, timbers were found to be below specification requirements with respect to slope of grain. In these, large checks near knots developed at an angle of about 20 deg. to the axis, making reinforcement advisable.

From December, 1937, to the summer of 1939, shrinkage of about 2 to 4 per cent of the depth of originally unseasoned members was observed. This was remedied by tightening rods and bolts in the main trusses. Because of the radial plane in which the purlin trusses were located, maintenance crews could not walk on the bottom chords. Hence, maintenance in the purlin was slighted to some extent and only the joints that could be reached from the main trusses received complete maintenance service. This maintenance difficulty suggests that radial position of purlin trusses should be avoided.

Many tension rods connecting top and bottom chords of the truss arches could not be tightened because sufficient force could not be applied by one man with a hand wrench. As it would not be economical to build a scaffolding expressly for this purpose, shrinkage space between butt blocks and compression diagonals was filled in with wood shingles used as driven shims. Checks in butt blocks of unseasoned Douglas fir were found generally to follow the plane of the holes made for tension rods and to extend to about one half the depth of the timber. Where the checking was deeper than this, repairs were made by nailing plumber's tape across the checks and to the vertical sides to prevent the block from sliding out should pressure from the diagonals be unevenly distributed.

Checking of timbers in the rod-and-block type construction was much more extensive than in the modern timber-connector types, perhaps because of the accumulated shrinkage effect of butt blocks and arch chords. Uneven shrinkage between adjoining panel points produces secondary stresses in main members with added bending and shearing stresses. Rod-and-block type arches also are subject to larger deflection because of greater shrinkage effects at the joints, with further increase of secondary stresses and apparent increase in checking of timber.

Modern timber-connector joints

Of the modern connector types, only split rings and flush-type shear plates were used. Wood-to-wood connections were made with split rings and bolts. Elsewhere, for greater loads, timber members were interconnected with steel gusset plates or with the strap-and-pin joints using flush-type shear plates and bolts.

The strap-and-pin joint is economical only where the number of joints may be kept to a minimum by the use of long members. Certain advantages arise from the fact that the pin-connected joint reduces secondary stresses induced in members by deflection, and distances between panel points are not affected by shrinkage. For example, in the south 130-ft.-high towers which were built in 1938 with strap-and-pin joints, examination in the summer of 1939 showed no need for maintenance, such as tightening of bolts. Although some shrinkage had taken place, additional clearance between steel straps and timber members added only small bending stresses to the bolts.

When designs for the buildings were prepared, there was some discussion as to the effect of checking and shrinkage on timber joints of the type shown at (*b*). Checks were expected along the lines *A* and *B* with a consequent decrease in efficiency of the joint. In practically all cases observed, these expected checks along these lines did not materialize.

Split rings gave satisfactory service despite working stresses 30 to 50 per cent more than usual; maintenance costs resulting from shrinkage were nominal.

A timber trestle with 12x12-in. posts has diagonal and horizontal bracing members 4 in. thick with connections between braces and posts made with 4-in. split rings and bolts. About a year after construction, it was found that in a few cases the split rings were partly out of their grooves, indicating (1) that bolts had not been properly tightened when put in, (2) that maintenance repairs should have been made earlier or possibly (3) that the rings had not been properly installed. In no other exposition structures, however, were similar conditions found.

In some timber arches of 136-ft. span, steel gusset plates were used with flush-type shear plates in the joint type illustrated as (*c*). Maintenance of these joints was confined to tightening bolts. Where steel gusset plates connect to a timber member with two rows of bolts, a saw cut permits shrinkage despite the maintenance of a constance distance between bolt lines. This saw cut also minimizes checking.

In some timbers, checks occurred along the centerline in the single rows of split rings or flush-type shear plates. These checks were of small structural significance because a connector engages a large area of timber and, when under stress, confines the wood within its diameter. Risk from such checking can be minimized by staggering the bolts or connectors. This should be done for other reasons wherever deep and thin members are used together. It was observed that some curling of members took place where this rule was not observed.

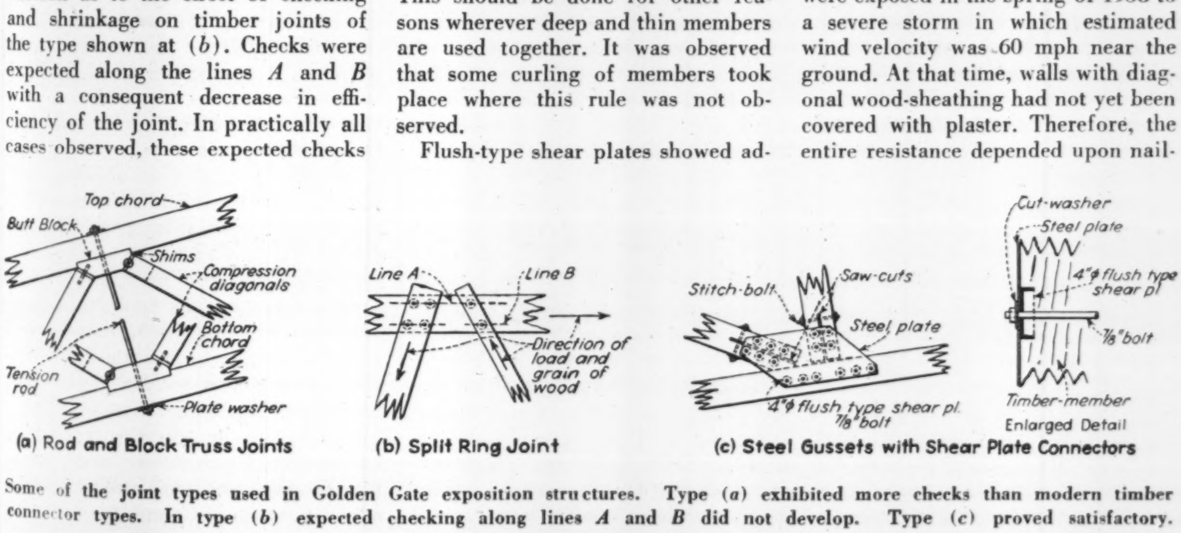
Flush-type shear plates showed advantage over other connectors in that shrinkage or checking of the timber produced less effect except in regard to bending stresses in bolts.

Plywood and nailed structures

In one of the major structures, a large number of plywood gusset plates 3 in. thick, 3½ ft. long by 6 ft. wide were used. These plates were made up of 29 plies using a phenol resin binder and were painted after erection in a location where they were exposed to the elements. After about fifteen months of exposure to sun, rain and fog, some of the plates developed defects in the form of separations between plies to a depth of 3 to 6 in. No defects appeared in the structure itself, and the extent of the ply separation and loss of structural efficiency will not be known until these plates are removed and tested.

In contrast with this defect, plywood used as an exterior sheathing (⅜-in., three-ply, hotpressed with phenol resin binder) was in all cases in sound structural condition after exposure averaging one year. In some instances, protective paint covering had fallen off where action of the elements was severe, resulting in slight checking and blistering of the plywood surfaces. These conditions could be prevented, it is believed, by better paint quality and proper maintenance. Plywood gusset plates used for resisting tensile stress indoors were in excellent condition after twenty months' use.

Large structures with nailed joints gave excellent performance. For example, the "Gates of the Pacific," Z-shaped in plan and 65 ft. high, were exposed in the spring of 1938 to a severe storm in which estimated wind velocity was 60 mph near the ground. At that time, walls with diagonal wood-sheathing had not yet been covered with plaster. Therefore, the entire resistance depended upon nail-



(a) Rod and Block Truss Joints (b) Split Ring Joint (c) Steel Gussets with Shear Plate Connectors

Some of the joint types used in Golden Gate exposition structures. Type (*a*) exhibited more checks than modern timber connector types. In type (*b*) expected checking along lines *A* and *B* did not develop. Type (*c*) proved satisfactory.

ing. Examination after the storm did not reveal any defects such as pulling out of nails or splitting at the ends of boards. Similarly satisfactory results were observed in large roof areas sheathed diagonally, where dependence upon stability of the structure against wind rested entirely with the nails.

Large and small timbers of untreated Douglas fir were used in contact with the ground, some buried and some partially exposed. Where these were examined after periods of one to two years, no deterioration of structural consequence was found.

In the design of about 1,000,000 sq.ft. of exhibit floors, live loads of 100 lb. per sq.ft. were assumed with a unit bending stress of 1,800 lb. per sq.in. for No. 1 common Douglas fir. In designing with these figures, stresses 50 per cent above generally accepted values were used. Very heavy exhibits were concentrated in some floor areas, while others supported closely-packed standing audiences or large dancing crowds, yet no indications of structural deficiencies in the floors developed.

Conclusions

Summing up the generally highly satisfactory performance of these exposition structures, one comes to the conclusion that many of the fundamental assumptions of design for large timber structures should be examined with a view to modification. In recent years progress of the art, grade-marked lumber, better manufacturing processes, and modern, more expert engineering design have brought about much higher standards in timber construction. For example, trusses designed with timber ring connectors, after undergoing the checking and shrinkage to be expected in unseasoned timber members, will give higher efficiency and lower risk than old-style rod-and-block trusses designed to the same standards.

The wholly satisfactory performance of exposition structures, designed with 50 to 100 per cent increases of the usual timber unit stresses, suggests that where competent engineers make the design and supervise construction and maintenance, building codes should be revised to provide for increased unit stresses—perhaps 30 to 50 per cent more than now permitted.

It is to be hoped that further support for such modification of approved design will result from the tests on the joints and other timber assemblies which it is proposed to make under direction of a special committee of the San Francisco Section, A.S.C.E., when the temporary buildings are demolished after the close of the exposition. Thus far, the proposed test program includes testing of connections, full-size trusses and arches, plywood panels, diagonally sheathed walls and the lateral load-resisting capacity of piles. Cooperation of the Forest Products Laboratory and the lumber industry generally has been invited.

Quite apart from this series of proposed tests, but as another corollary to observations on modification of design standards arising from experience with exposition structures, is the urgent need for more definite data on what constitutes adequate provision for wind loads. Maximum wind velocities recorded in the San Francisco Bay region in March, 1938 (one of the most severe storms in a 25-yr. period) amounted to 60 mph. The duration of severe intensity was about one-half hour, and none of the structures or elements than on the exposition grounds suffered the slightest damage. Nor were any structural failures reported in San Francisco, although doubtless many wooden houses in the city are far below present-day rigid wind resistant specifications. This 60-mph wind corresponds to a pressure of 11½ lb. per square foot in contrast with the 15 lb. required by California state law.

Thus it would appear that definite information on wind loads, with reasonable allowance for combination of wind loads with other occasional loading, might bring about important modification of present wind loading requirements, which in the writer's opinion are imposing unreasonable limitations, particularly now that the resistance to horizontal forces set up by earthquakes are separately considered.

Design and maintenance of timber structures in 1939 was under the direction of the writer; W. P. Day, vice-president and director of works, Golden Gate International Exposition, was in charge of all exposition construction.

Engineering in Relation To Traffic Safety

Engineering, enforcement and education are the "three essential E's" in a balanced program of highway traffic safety, according to a pamphlet on "Safety for Your Community," issued by the Ohio State Department of Highways, in which these three essentials are discussed. Engineering plays an important part in the solution of the traffic accident problem, as in the location, design, construction and maintenance of roads and streets; in traffic control or regulation, and in standardizing signs and markers, and eliminating potential traffic hazards. Enforcement of laws and regulations is vital to effective traffic control. For most drivers the signs and warnings are sufficient, but there are always some who can be reached only by the arm of the law. But too drastic a campaign of enforcement may arouse antagonism and so defeat its purpose.

Traffic engineering is said to consist of the application of engineering principles to the discovery and solution of traffic problems. Its activities include: (1) routing of traffic; (2) conducting traffic surveys and counts, and other factual investigations; (3) the installation and maintenance of traffic signals, signs and markers, and the timing of traffic signals; (4) studying laws and regulations with a view to improvements; (5) cooperation with officials in development of plans for road and street improvements; (6) analysis of accident records and devising remedial measures; (7) preparation of facts and material for educational purposes. Communities which do not have traffic engineers may have surveys and other activities carried out by consulting engineers.

An efficient system of accident reporting and recording is necessary, but records alone have no direct effect. They need to be studied to determine the remedies required, and then action must be taken to carry out these remedies. Spot maps (general and local), to indicate the location and types of accidents, are useful in showing the accident situation. To carry on an effective program of accident prevention and public education requires an efficient and active permanent organization.

FROM FIELD AND OFFICE

Working problems and time-saving methods for engineers and contractors

Special Cars Reduce Hazard Of Transporting Explosives

An explosives car for use in underground construction should consist essentially of two boxes, so constructed that the inner box is insulated adequately from electric current, and should be strong enough to withstand more than normal blows, such as falls of material and similar accidental impact. It should have doors or lids that can be opened to expose only a part of the load at one time. Doors should be placed so they will not come in contact with electric power wires when opened, and in such location that employees cannot stand under power-carrying wires while loading or unloading explosives. Bumpers should be prohibited or so constructed that employees cannot ride on the car.

As electric haulage is generally used, insulated couplings should be employed with this type of transportation, to prevent ignition or detonation of the explosives by stray currents. Ordinary couplings allow current, created usually when the locomotive and cars run over poorly bonded track, to pass into the car through the metallic draw bar.

Some companies provide separate compartments in explosives cars to carry detonators, but the Bureau of Mines believes this practice entails additional and unnecessary danger and does not recommend this departure from the much safer practice of transporting different types of explosives and detonators separately.

The above is condensed from Information Circular 7115, "Cars for Transporting Explosives," by C. W. Owings, copies of which may be obtained from the Bureau of Mines, U. S. Dept. of the Interior, Washington, D. C.

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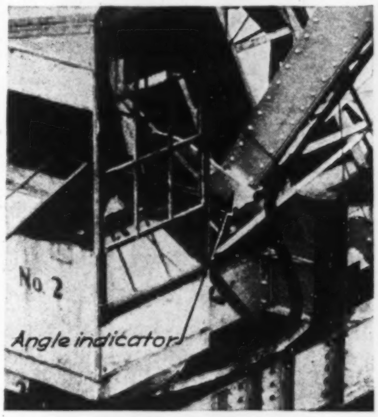
Boom Angle Indicator

An indicator to show the angle of the boom has been installed in each of several big revolving floating cranes on the Pennsylvania Ave. bridge job in Washington, D. C., by Penker Construction Co., Cincinnati, contractor on the sub-structure. The indicator consists of a pointer arm welded to the side of the boom near the base. The pointer describes an arc close to the window between operator and boom, and as the boom is raised or lowered marks on the window show the operator the position of the boom at all times. The device has been found extremely useful in placing concrete, as the boom angle must be changed between spotting the bucket for loading and for discharging into the forms. The operator can note the position of the indicator when the boom is in correct position for each operation, then by bringing the indicator to the predetermined position for each move the boom is automatically brought to the desired angle. Ben Harig, superintendent for Penker, devised the indicator.



Boom indicator shows angle of crane boom at all times.

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Spray Curtain Stops Carbon Monoxide

From the Delaware Water Supply News
New York City

Carbon monoxide gas is present after every tunnel blast delaying work at the heading until the ventilation system reduces the fumes to a harmless amount. To keep these fumes concentrated near the heading to facilitate their complete removal by suction from the tunnel, a heavy water spray has been developed to curtain the tunnel just back of the ventilator intake.

This spray consists of a piece of 3-in. pipe about 3 ft. long. One foot from the end, the pipe is heated and bent up at an angle of 30 deg. The bent end is then heated and pressed together, leaving a flat opening approximately 4 in. long and ¼ in. wide; 6 in. back of the flattened end, and parallel to the 2 ft. of straight pipe, a 1-in. standard iron pipe is welded into the 3-in. pipe. The open end of the 3-in. pipe is fitted with a swivel joint connection which is attached to the main high-pressure airline outside the main air cock about 80 to 100 ft. back from the face. The high-pressure waterline that feeds the drills on the jumbo is attached to the 1-in. iron pipe. When the heading is loaded, and ready to shoot the water and then the air is turned on. The water is under a pressure of about 75 lb. per sq. in. and the air at 100 lb. per sq. in. The 30-deg. angle bend has sufficient leeway to twist and adjust the spray at the

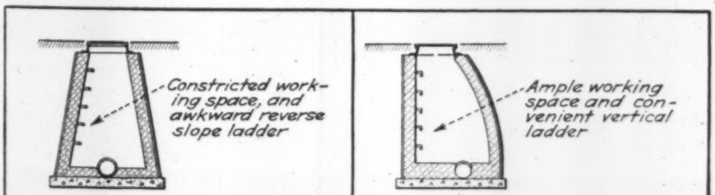
Constricted working space, and awkward reverse slope ladder
Ample working space and convenient vertical ladder

FIG. 1

FIG. 2

EASING THE CLEANER'S JOB

From the Clay Sewer Pipe Association come these two sketches of sewer manholes to illustrate a possibility for making the cleaner's job easier and a probability of getting a better cleaning job.

Spray curtain (about 125 gpm) to check movement of gas from tunnel heading.

desired angle to throw a heavy water spray curtain (approximately 125 gpm) across the entire tunnel. The blast gases and dust are blown into and through the water curtain, which continues to spray the remaining dust, smoke and fumes. With the fan exhausting, what gases and smoke and dust have passed through the spray are now drawn back through the spray curtain and practically eliminated.

When the blaster returns to the heading after the blast, the water and air are shut off and the spray removed. Five minutes after the blast tests show that there is practically no carbon monoxide, combustible gas, powder smoke or fumes left in the tunnel. The muck pile, the heading and the tunnel walls have been wet down by the action of the spray, and the men can return to clean atmosphere in the heading within 5 to 15 min. after the blast. The smoke cone and dust that usually hang in the heading after the fans are reversed and are blown back into the tunnel toward the shaft are practically eliminated. This spray saves more time (5 to 20 min. per shot) and eliminates more smoke and dust nuisance than any recent changes in blasting operations. The scheme was worked out by George Underwood, tunnel superintendent at Shaft 4, and Palmer Tubbs, safety superintendent of the Walsh Construction Co. on the Delaware Aqueduct.

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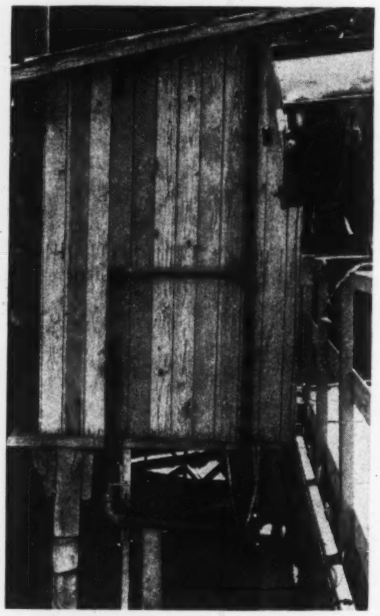
Flush-Type Lavatory



Here is an ordinary flush-type toilet and lavatory, as plumbing on the outside of the shack indicates, but it is unusual in its location. These conveniences are halfway up the tall steel structure at Friant Dam that houses the concrete mixing plant. Toilets, lavatories and cooled drinking water wherever the men work are the rule on this job. Eighteen flush-type toilets and twelve of the WPA type, inspected and cleaned daily, have been put where they contribute most to the convenience and efficiency of the workmen.

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Fiber Board Houses

As part of an extensive investigation of materials and structures for low-cost houses, the National Bureau of Standards, Department of Commerce, has been conducting studies of the relative lasting qualities of fiber insulating boards. Accelerated aging tests were used to produce, in a relatively short time, effects similar to those likely to arise from long periods of service.

In general, the retention under the aging treatments of the most essential properties of the boards—thermal conductivity and strength—was excellent.

It was found the fiber boards did not support the growth of rot producing fungi except at relative humidities above 85 per cent. The growth of fungi at higher humidities was appreciably retarded by impregnating the boards with fungicides.

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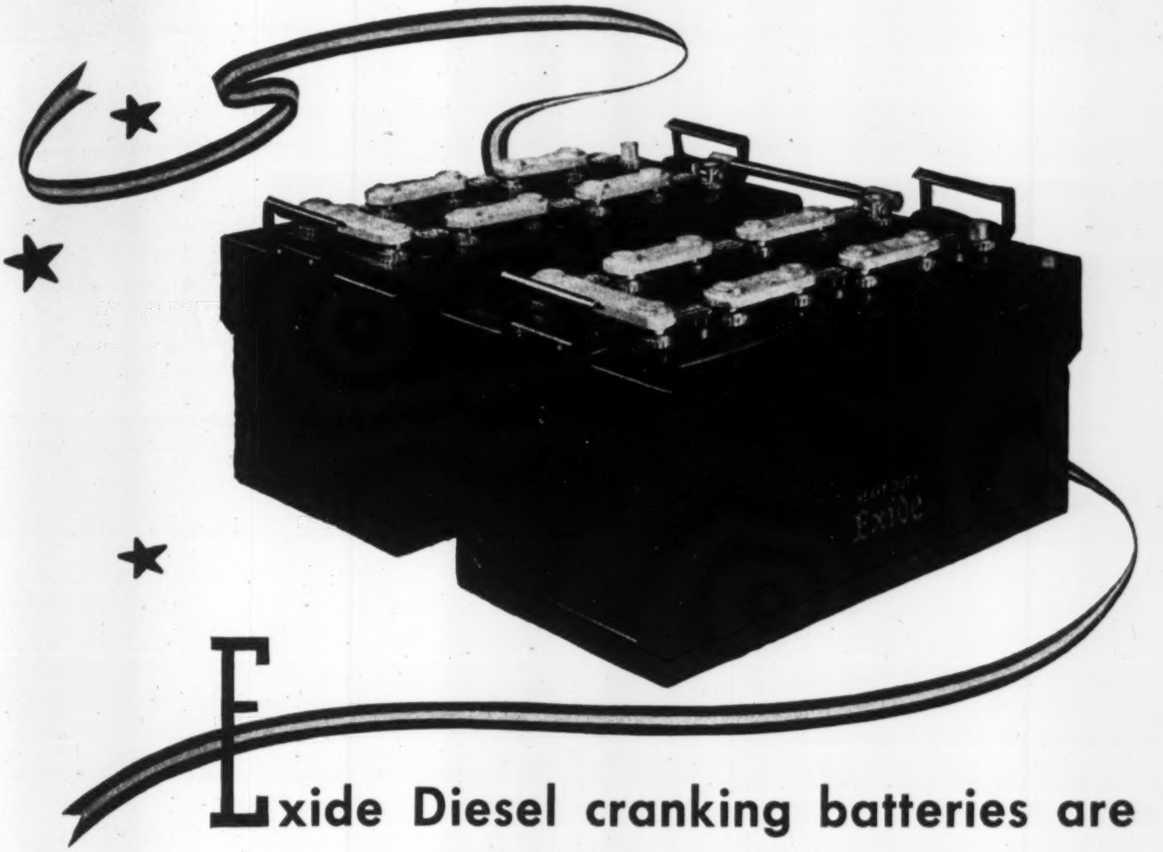
Flashing Protects Steel

Complete protection from roadway drainage water is provided for all steelwork on Cleveland's Main Avenue Bridge by extensive use of copper flashing at all floor openings. Roadway surfaces are built without crown and are sloped longitudinally to the end of each span, thus bringing the water to the transverse drains which consist of flat plates equipped with two lines of staggered oval holes; at the expansion ends of the truss spans the toothed joints serve as drains. Beneath all of these cross deck openings the copper flashing is installed, as shown in the accompanying illustration, to lead the water to galvanized troughs that slope to collecting hoppers over the cast iron pipe down spouts inside the hollow piers.

Cross trough beneath deck of Main Avenue Bridge in Cleveland into which water is guided by the inclined flashing.



Exide Diesel cranking batteries are a part of Diesel engine tradition . . .

ELECTRIC CRANKING of Diesel engines followed closely on the development of the modern, high-speed engine of this type. It was made both practical and economical by means of storage batteries which provide the necessary high cranking speed for quick starting.

These batteries were developed by Exide, through a research and engineering program conducted at the same time as the industry-wide development of the modern Diesel engine. Battery and engine were presented to users practically together, and have since been working together in every field in which the Diesel engine has earned an accepted place.

All of Exide's experience in this specialized service is built into Exide Batteries for Diesel engine cranking. That is why you can place such complete confidence in the ability of Exides to do their job faithfully and economically, adding to the dependability of your Diesel-powered equipment under every condition the year 'round.

Exide
BATTERIES
FOR CRANKING DIESEL ENGINES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

MARSHALL FORD DAM COMPLETION, TEXAS

OWNER: Bureau of Reclamation, Colorado River Project, Texas. E. A. Moritz, construction engineer.

PROJECT: Completion of concrete section of Marshall Ford Dam (Schedule 1) and construction of embankments (Schedule 2). Work located at the Hughes site on the Colorado River, 18 miles northwest of Austin, Tex. Provides for a concrete straight-gravity dam, with maximum height of 270 ft., and crest length of 2,623 ft. Dam is to be flanked on left abutment by rolled earth embankment 105 ft. high and 2,500 ft. long. Earth embankment protected by rock face on both upstream and downstream slopes. Spillway, located in river channel, is of ogee type.

CONDITIONS: Government to furnish all cement, steel, pipe, seals, spillway outlet bulkhead-gate guides, penstock-gate guides and hoists, miscellaneous metalwork, electrical conduit, conductors, wires and equipment, plumbing fixtures, and structural glass. Schedule 1 to be completed in 525 calendar days, and Schedule 2 in 450 calendar days. Rail transportation facilities available. Wage rates in Austin, Texas area are: skilled, $1.25 to $1.50 per hr.; semi-skilled, 87½c. to $1.12½; and common labor 65c. per hr.

BIDS: Two bids were received on each schedule June 14, 1940 as shown below. Contract awarded to low bidders July 31, 1940.

Schedule 1—Completion of Concrete Section

LIST OF BIDDERS:

1. Brown & Root, Inc., and McKenzie Constr. Co., Austin, Tex. (contract)	$3,137,495
2. Al Johnson Construction Co., Minneapolis, Minn.	3,353,649

Item	Quan.	Unit Prices (1)	(2)
1. Excav., common, dam fndn	12,000 c.y.	$1.50	$1.00
2. Excav., rock, dam fndn	83,000 c.y.	1.50	2.00
3. Excav., open cut, fndn. cut-offs	140 c.y.	11.00	10.00
4. Excav., drifts, fndn. cut-offs	380 c.y.	25.00	15.00
5. Excavation of concrete	1,650 c.y.	40.00	27.00
6. Remove concrete parapet	165 c.y.	14.00	11.00
7. Chip and roughen exist. conc. surf.	2,760 s.y.	3.00	1.00
8. Backfill	30,000 c.y.	.30	.30
9. Drill holes; fndn. drain. pipes	100 ea.	1.40	1.50
10. Drill holes, dam fndn., und. 25-ft	1,000 l.f.	1.25	1.50
11. Drill drainage holes, 25–50-ft	3,500 l.f.	1.60	1.80
12. Mfr. and place porous-conc. drain tile	26,000 l.f.	1.12	1.00
13. Drill grout holes, under 25-ft	2,500 l.f.	.70	.50
14. Drill grout holes, 25–50-ft	3,000 l.f.	.85	.70
15. Drill grout holes, 50–100-ft	10,000 l.f.	1.10	.90
16. Drill grout holes, 100–150-ft	1,000 l.f.	1.25	1.00
17. Pressure grouting foundations	16,500 c.f.	1.40	1.25
18. Inst. tub. and fittings for grouting contract. joints, drifts	95,000 lb.	.21	.25
19. Inst. anchorages for grout outlets	1,900 ea.	2.00	1.20
20. Pres. grout. contraction jts, drifts, cooling sys	5,500 c.f.	2.80	1.25
21. Concrete in dam	455,000 c.y.	5.25	5.65
22. Conc.; sidewalks, curbs, parapets	1,500 c.y.	20.00	20.00
23. Conc.; spillway train. walls; above El. 670	400 c.y.	14.00	15.00
24. Conc.; trashrack structures	2,150 c.y.	40.00	30.00
25. Conc.; penstock-gate struct	1,700 c.y.	12.00	20.00
26. Conc.; spillway-bridge piers	1,800 c.y.	10.00	17.00
27. Conc.; spillway-br. deck, parking area	570 c.y.	11.00	30.00
28. Conc.; elevator tower	480 c.y.	30.00	45.00
29. Conc. fill; galleries, shaft, drifts	400 c.y.	10.00	8.00
30. Place rein. bars and fabric	1,332,000 lb.	.02	.02
31. Drill holes; anchor bars and grout bars in place	3,500 l.f.	1.00	1.00
32. Metal sealing strips in contr. jts	20,300 l.f.	.60	.50
33. Metal-seal intersection unit between L and Z type seals	55 ea.	3.00	15.00
34. Cut and shape exist. L and W type metal seals in contr. jts	2,710 l.f.	.80	.80
35. Dehydrated cork in contr. joints	880 s.f.	.30	1.00
36. Felt contraction-joint seal	50 s.f.	.80	1.00
37. Remove felt seals from contr. joints	3,800 l.f.	.30	1.00
38. Metal tubing and fit., conc. cooling sys	98,000 lb.	.25	.25
39. Operate plant for cooling concrete	200 days	225.00	200.00
40. Finish lighting recesses	110 ea.	1.50	4.00
41. Inst. asph.-saturated-felt roofing, with flashing	360 s.f.	.50	.20
42. Lightweight conc. in floor	10 c.y.	30.00	7.00
43. Bonded conc. floor finish	50 s.y.	1.50	4.00
44. Terrazzo treads, risers, wall base; for stairs	230 s.f.	2.00	3.50
45. Place terrazzo floors and landings	700 s.f.	.70	1.00
46. Place terrazzo cove wall base	200 l.f.	.85	2.00
47. Place glass-block panel	130 s.f.	1.40	1.50
48. Constr. struct.-glass walls and wainscots	650 s.f.	1.40	1.00
49. Constr. struct.-glass partitions	140 s.f.	1.40	1.00
50. Constr. suspended ceiling	30 s.y.	3.00	2.00
51. Port. cem. plaster; walls and ceilings	270 s.y.	1.40	1.00
52. Inst. plumbing fixtures	1,700 lb.	.20	.50
53. Inst. metal doors	170 s.f.	.30	1.00
54. Inst. metal louvers and windows	280 s.f.	.70	.50
55. Aluminum handrails and curbs	400 lb.	.30	.40
56. Inst. toilet-stall doors	6 ea.	7.00	7.00
57. Attaching letters	L.S.	35.00	100.00
58. Inst. trashrack metalwork	1,081,000 lb.	.025	.02
59. Spillway outlet bulkhead-gate guides	270,000 lb.	.085	.06
60. Penstock-gate guides	16,800 lb.	.085	.05
61. Penstock-gate hoists	240,000 lb.	.017	.03
62. Str. steel, spillway bridge	1,190,000 lb.	.01	.03
63. Inst. metal stairways	13,000 lb.	.10	.05
64. Metal floor plates and gratings	2,500 lb.	.08	.05
65. Inst. std. met. pipe and fittings, valves under 6-in	37,000 lb.	.08	.10
66. As above, 6-in. and over	196,000 lb.	.035	.10
67. Install pipe handrails	2,500 lb.	.03	.30
68. Remove pipe handrails	24,500 lb.	.02	.20
69. Inst. misc. metalwork	20,000 lb.	.11	.05
70. Elec. met. conduit, 1¼-in. or less	11,000 l.f.	.30	.20
71. Same, 1¼-in. to 3-in	1,800 l.f.	.35	.50
72. Inst. elec. conductors	12,300 lb.	.35	.04
73. Install ground wires	200 lb.	.15	.20
74. Install electrical equipment	1,300 lb.	.25	.50

Schedule 2—Earth Embankments

LIST OF BIDDERS:

1. Cage Bros. and W. W. Vann & Co., Bishop, Tex. (contract)	$903,102
2. Brown & Root, Inc., and McKenzie Constr. Co., Austin, Tex.	1,296,198

Item	Quan.	Unit Prices (1)	(2)
1. Excav., stripping borrow pits	70,000 c.y.	$0.11	$0.14
2. Com. excav., strip. for embank	160,000 c.y.	.10	.20
3. Com. excav., embank. cut-off trenches	42,000 c.y.	.20	.56
4. Rock excav., embank. cut-off trenches	11,000 c.y.	.60	.56
5. Rock excav., footing conc. cut-off wall	1,300 c.y.	6.25	10.00
6. Com. excav., for drains	1,400 c.y.	1.25	.65
7. Rock excav. for drains	270 c.y.	3.00	10.00
8. Com. excav., roads and parking areas	10,000 c.y.	.11	.32
9. Rock excav., roads and parking areas	26,000 c.y.	.55	.84
10. Backfill	100 c.y.	1.00	.65
11. Common excav., borrow pits; haul to embank	1,400,000 c.y.	.19	.29
12. As above, rock excav	106,000 c.y.	.60	.75
13. Earth fill in embank	1,230,000 c.y.	.13	.13
14. Gravel fill in embank	160,000 c.y.	.30	.25
15. Gravel blanket, upstream slope	2,800 c.y.	.40	.40
16. Remove riprap and rock fill	2,600 c.y.	.30	.65
17. Rock fill, slopes of embank	170,000 c.y.	.10	.48
18. Riprap on upstream slopes	67,000 c.y.	2.75	3.95
19. Cr. grav. or cr. rock base crse for road and walk surfacing	3,900 c.y.	1.85	1.60
20. Watering, rd. and walk surf	75,000 M gal.	1.50	2.00
21. Apply bit. prime and seal coats	11,000 gal.	.03	.03
22. Cr. grav. or cr. rock surf. crse	1,350 c.y.	2.00	1.60
23. Distr. asph. oil for surf. crse	25,000 gal.	.03	.03
24. Mix, compact and finish road-mix oil surf	19,000 s.y.	.07	.08
25. Coarse sand for seal coat of surf	125 c.y.	1.60	2.00
26. Remove sew. pipe from embank. toe drain	1,000 l.f.	.10	.57
27. 8-in. sew. pipe drains, uncem. jts, in gravel	3,000 l.f.	.40	.94
28. Lay 12-in. corr. met. pipe	650 l.f.	.10	.60
29. Inst. std. met. pipe, fittings, valves	30,000 lb.	.01	.06
30. Drill grout holes, to 25 ft	2,000 l.f.	.30	.70
31. Drill grout holes, 25 to 50 ft	4,000 l.f.	.50	.85
32. Drill grout holes, 50 to 100 ft	13,500 l.f.	.65	1.10
33. Drill grout holes, 100 to 150 ft	3,000 l.f.	1.00	1.25
34. Pressure grouting foundations	35,000 c.f.	.65	1.40
35. Conc. in embank. cut-off wall	2,300 c.y.	9.00	9.40
36. Conc., in parapet, curbs and drainage struct	1,400 c.y.	15.00	20.00
37. Place reinf. bars and fabric	200,000 lb.	.01	.019
38. Inst. misc. metalwork	8,200 lb.	.01	.10
39. Construct guardrail	6,200 l.f.	.30	.45
40. Inst. elec. metal conduit, 1¼ to 3 in.	2,550 l.f.	.05	.35
41. Install electrical conductors	3,500 lb.	.10	.35
42. Install ground wires	100 lb.	.20	.15